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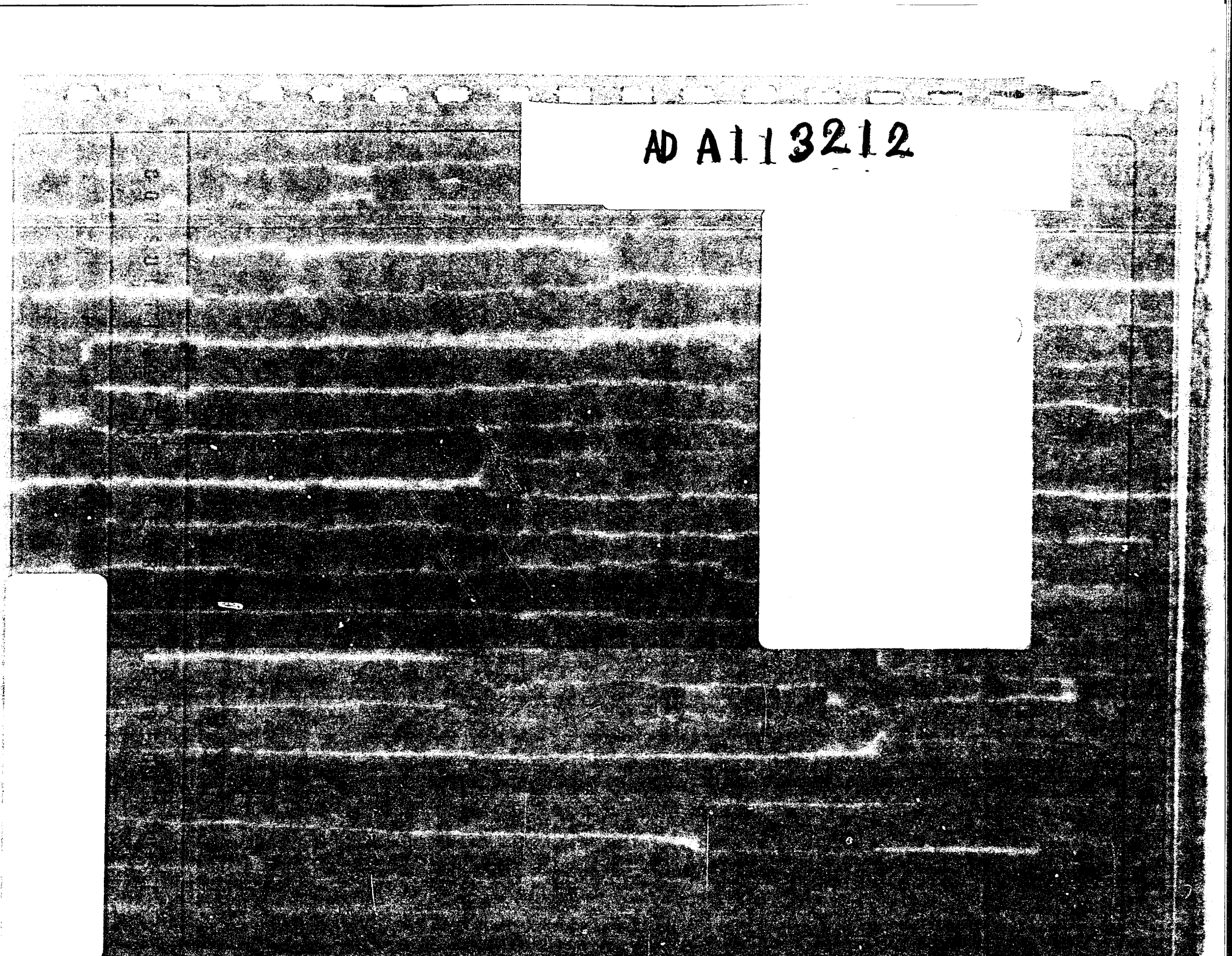

FN-TR-ETB-1

PROGRESS REPORT

GEOTECHNICAL STUDY FOR

MOBILITY TEST TRACKS

ETB MOBILITY STUDY

NEVADA TEST SITE, NEVADA

Prepared for:

U.S. Department of the Air Force
Ballistic Missile Office
Norton Air Force Base, California 92409

Prepared by:

Fugro National, Inc.
3777 Long Beach Boulevard
Long Beach, California 90807

29 August 1980

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19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

Geology, Nevada Test Site, test track, Pit Logs, Density Results, ~~EDK~~ California Bearing Ratio, Cone Penetration Tests, moisture content tests, triaxial compression tests

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

Summary of a geotechnical study for mobility test tracks at the southwest corner of the Nevada Test Site, Lathrop Wells, Nevada giving the engineering properties for these ~~test tracks~~.

DD FORM 1 JAN 73 1473 EDITION OF 1 NOV 65 IS OBSOLETE

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FOREWORD

This report was prepared for the Department of the Air Force, Ballistic Missile Office (BMO) under Contract No. F04704-80-C-0006. It is a progress report and presents the results of a geotechnical study performed at the mobility test tracks in Engineering Test Bed at Nevada Test Site, Nevada. Further studies are scheduled during and after the mobility tests. It is planned to prepare additional progress reports following these studies.

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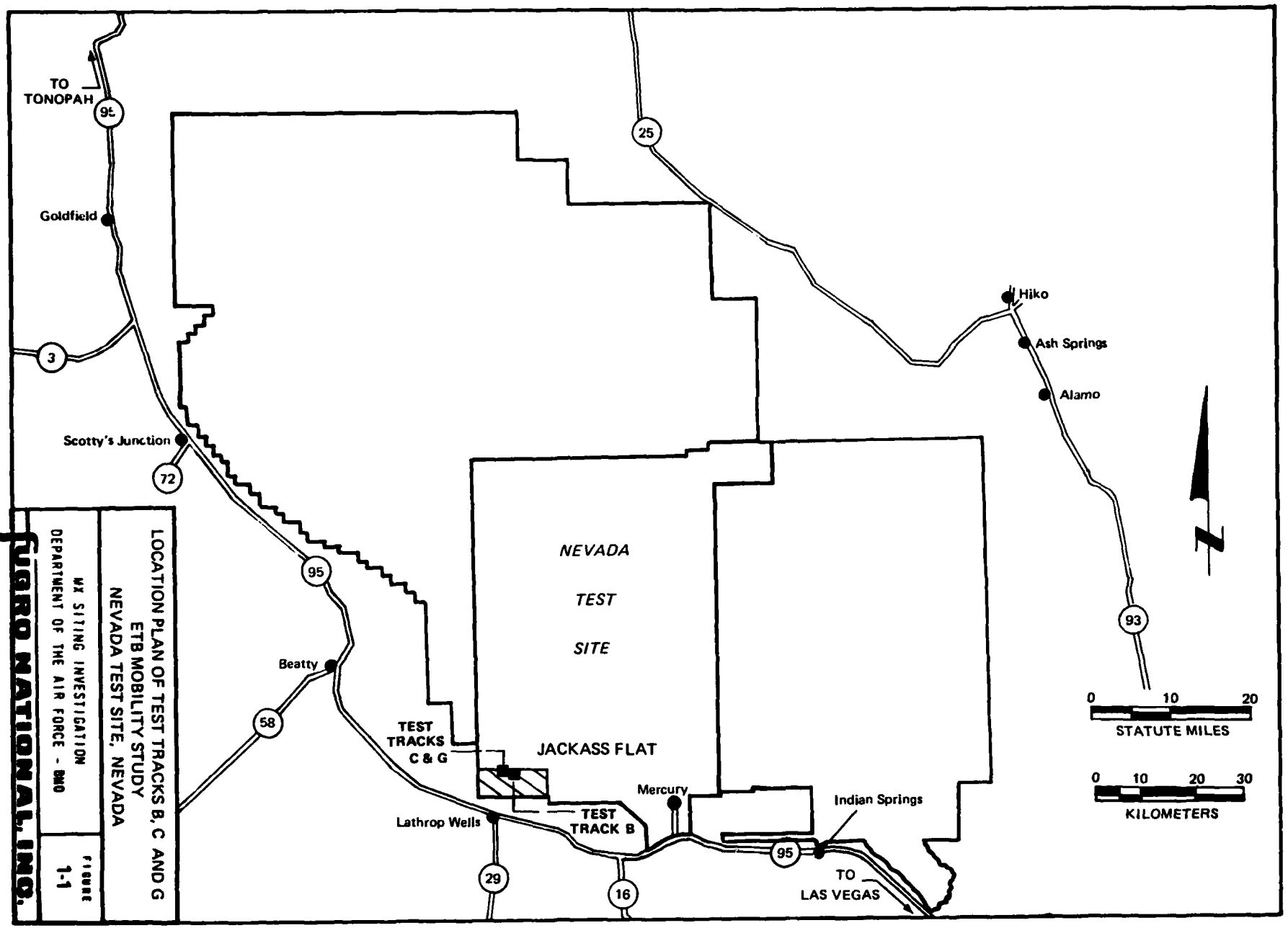
1.0 INTRODUCTION

1.1 BACKGROUND

This progress report presents the results of the geotechnical study performed at the three road test tracks at Engineering Test Bed (ETB) in Nevada Test Site, Nevada (see location map in Figure 1-1). The test tracks are part of the mobility study planned by the Boeing Company in which a Terex 33-15 vehicle will traverse the tracks. The test tracks are located northeast of the previously constructed prototype vertical shelter and loop road. This study was performed to determine the geotechnical properties of the soils at the test tracks. Further studies are planned during and after the mobility tests.

1.2 TEST TRACKS

The three test tracks are designated as test tracks B, C, and G and were constructed by small amounts of cut and fill. Neither compaction nor treatment of the graded soils was performed. However, the surficial soils may have been compacted slightly due to the operation of construction equipment. Tracks B and C were constructed prior to April 1980 while track G was constructed between 12 August and 17 August 1980. Track B is 1900 feet long and is located in the flank of the Little Skull Mountain. It consists of two sections; one from Station 0+00 to 6+00 with four percent grade and the second from Station 7+00 to 19+00 with one percent grade. The two sections are approximately perpendicular to each other. Tracks C and G are 1200 feet long located in the center of the valley, and have 0.5 percent grade.


TO TONOPAH
95
Goldfield
3
Scotty's Junction
72
95
Beatty
58
25
Hiko
Ash Springs
Alamo
93
NEVADA
TEST
SITE
TEST TRACKS C & G
JACKASS FLAT
TEST TRACK B
Mercury
Indian Springs
Lathrop Wells
29
16
95
TO LAS VEGAS
0 10 20
STATUTE MILES
0 10 20 30
KILOMETERS
LOCATION PLAN OF TEST TRACKS B, C AND G
ETB MOBILITY STUDY
NEVADA TEST SITE, NEVADA
MX SITING INVESTIGATION
DEPARTMENT OF THE AIR FORCE - BMO
FIGURE
1-1
FUGRO NATIONAL, INC.

1.3 SCOPE

The scope of this study consisted of the following:

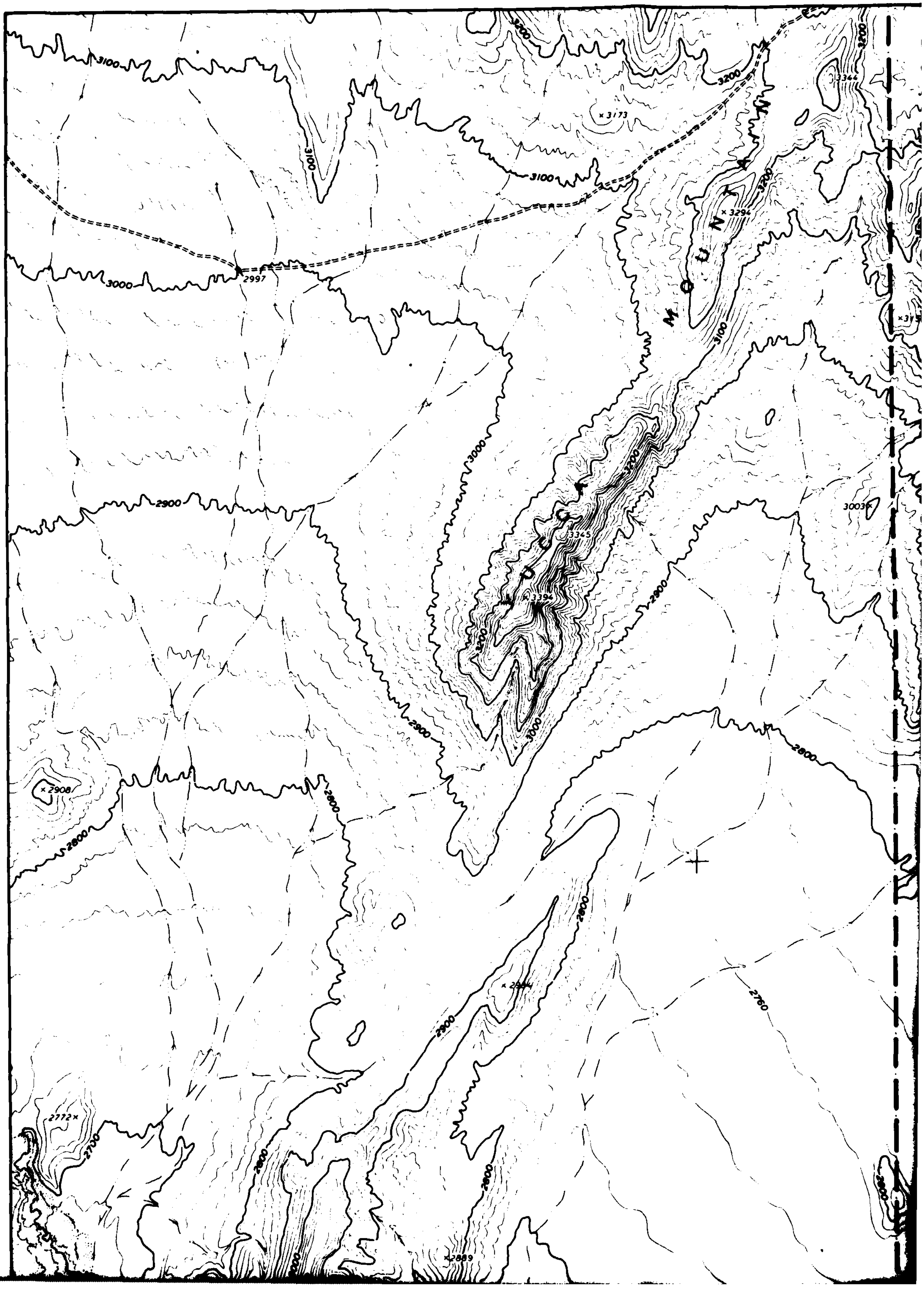
- Field investigation: Cone Penetration Tests (CPTs), test pits and in situ field density and moisture content tests;
- Laboratory investigation: Classification, compaction, relative density, California Bearing Ratio (CBR), and triaxial compression tests;
- Data analysis: Summary of the field conditions, physical and engineering properties of soils at the test tracks, and discussion on pre- and post-mobility test CPTs at track C.

2.0 GEOLOGY

2.1 GENERAL

The three test tracks, are in Jackass Flats located in the south west corner of the Nevada Test Site. The area is just north of U.S. Highway 95 at its junction with State Highway 29 at Lathrop Wells, Nevada (Figure 2-1). Jackass Flats is located within the Great Basin physiographic province, an area characterized by large fault-block mountain ranges separated by aggrading alluvial basins. The test tracks are bounded on the north by the Little Skull Mountains which are composed chiefly of Tertiary basalt with minor ash-flow tuffs. The Striped Hills are located in the southern end of the site and consist of lower-Paleozoic limestone and dolomite. The western boundary is along Fortymile Wash, a deeply incised channel which flows southward into the Amargosa Desert.

The principal surficial geologic units are alluvial fan deposits of young (A5y) to intermediate (A5i) age. These deposits consist of sand and gravel, moderately to well-cemented by caliche. Overlying the alluvial fan deposits is a veneer of eolian sand (A3s) which ranges in thickness from zero to over 5 feet. Fluvial or stream channel deposits (A1) consisting of loose sand, gravel, cobbles, and boulders, are found along Fortymile Wash and Topopah Wash as well as numerous smaller drainages which generally flow south-southwesterly across the site.


3100
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×3173
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M O U N T A I N
2997
3000
3100
3200
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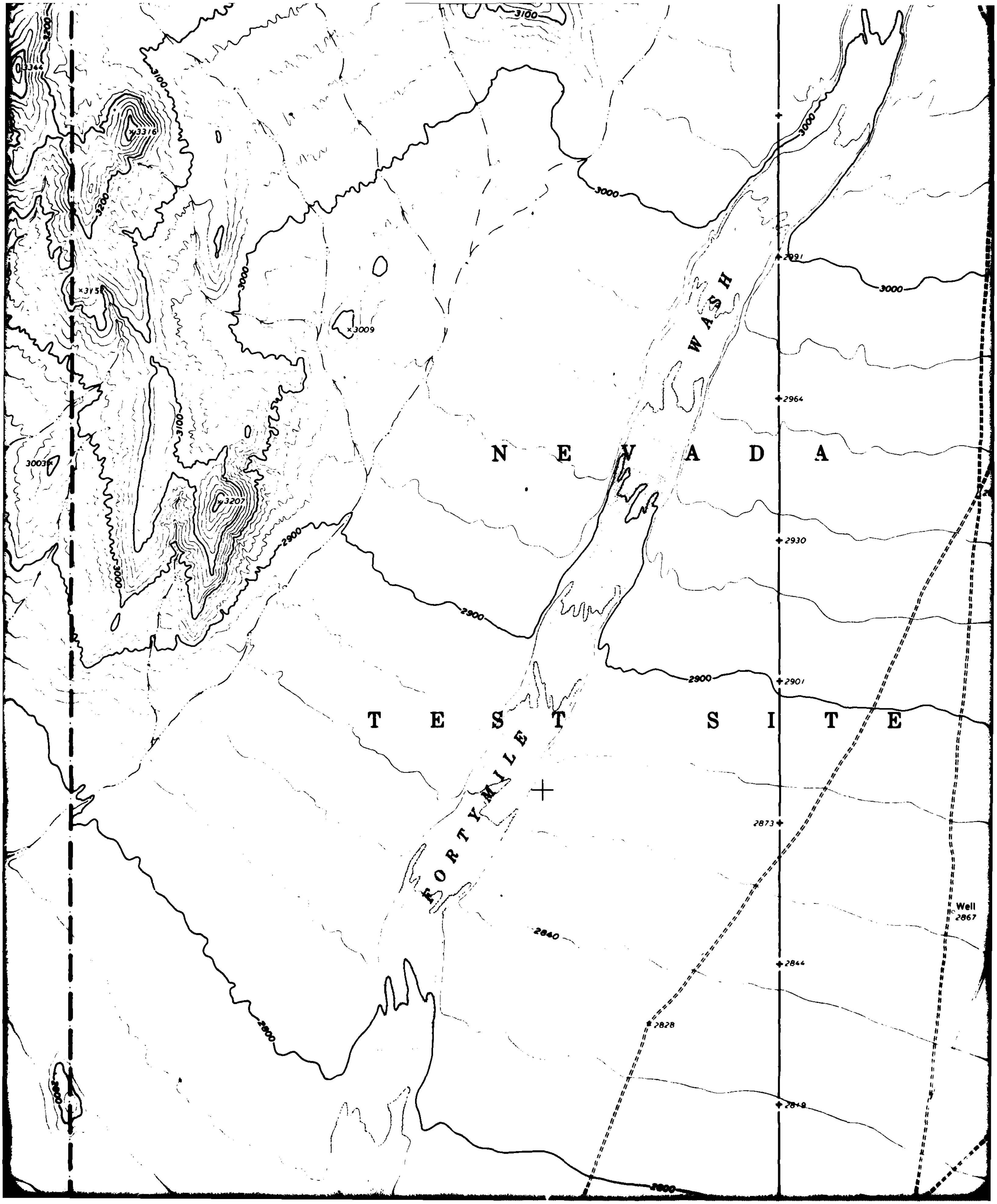
3003
2800
×2908
3000
2900
2800
2760
2772×
2700
×2889


NEVADA
TEST SITE
FORTYMILE
WASH
3100
3200
3344
3316
3000
3009
3003
3207
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2991
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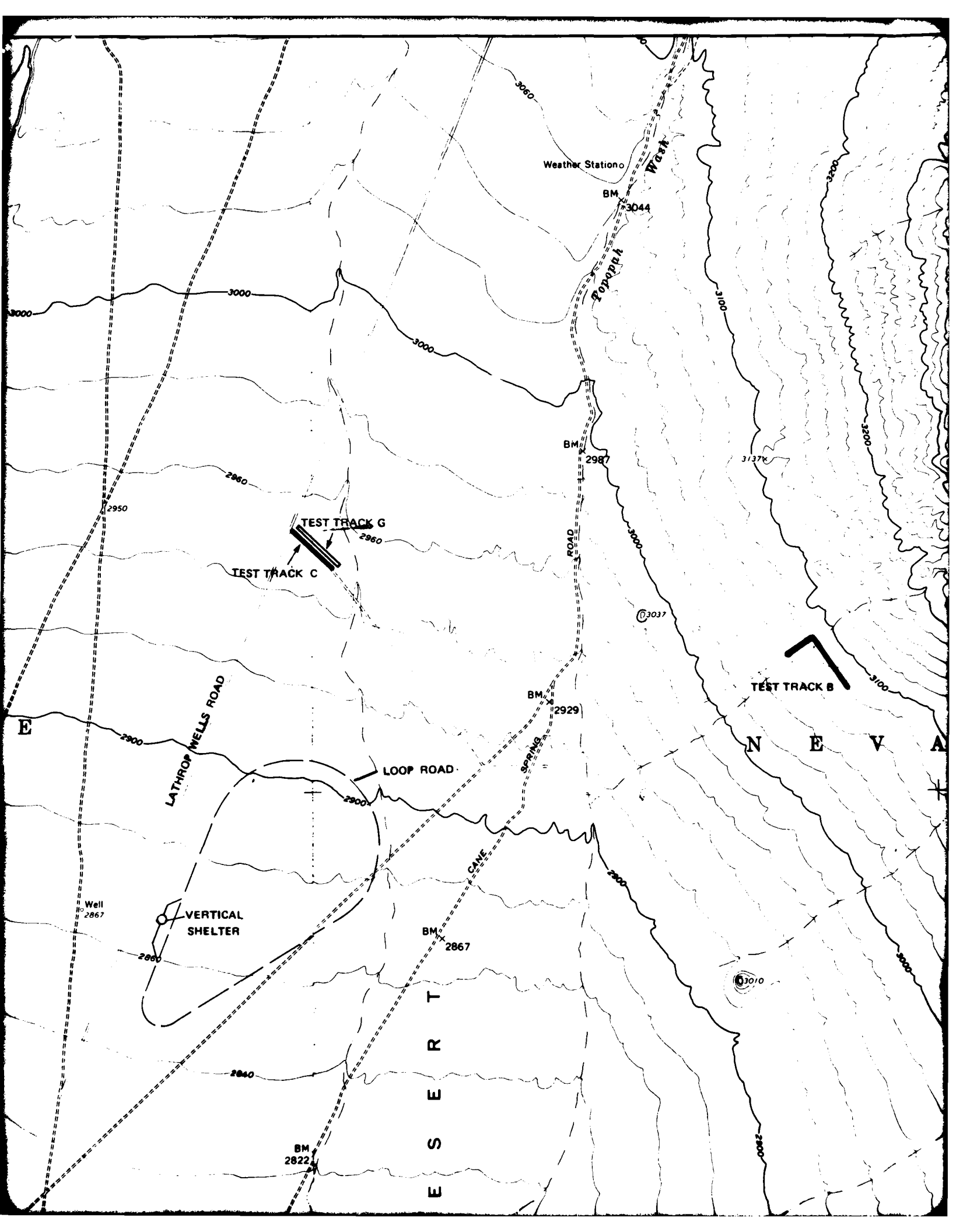
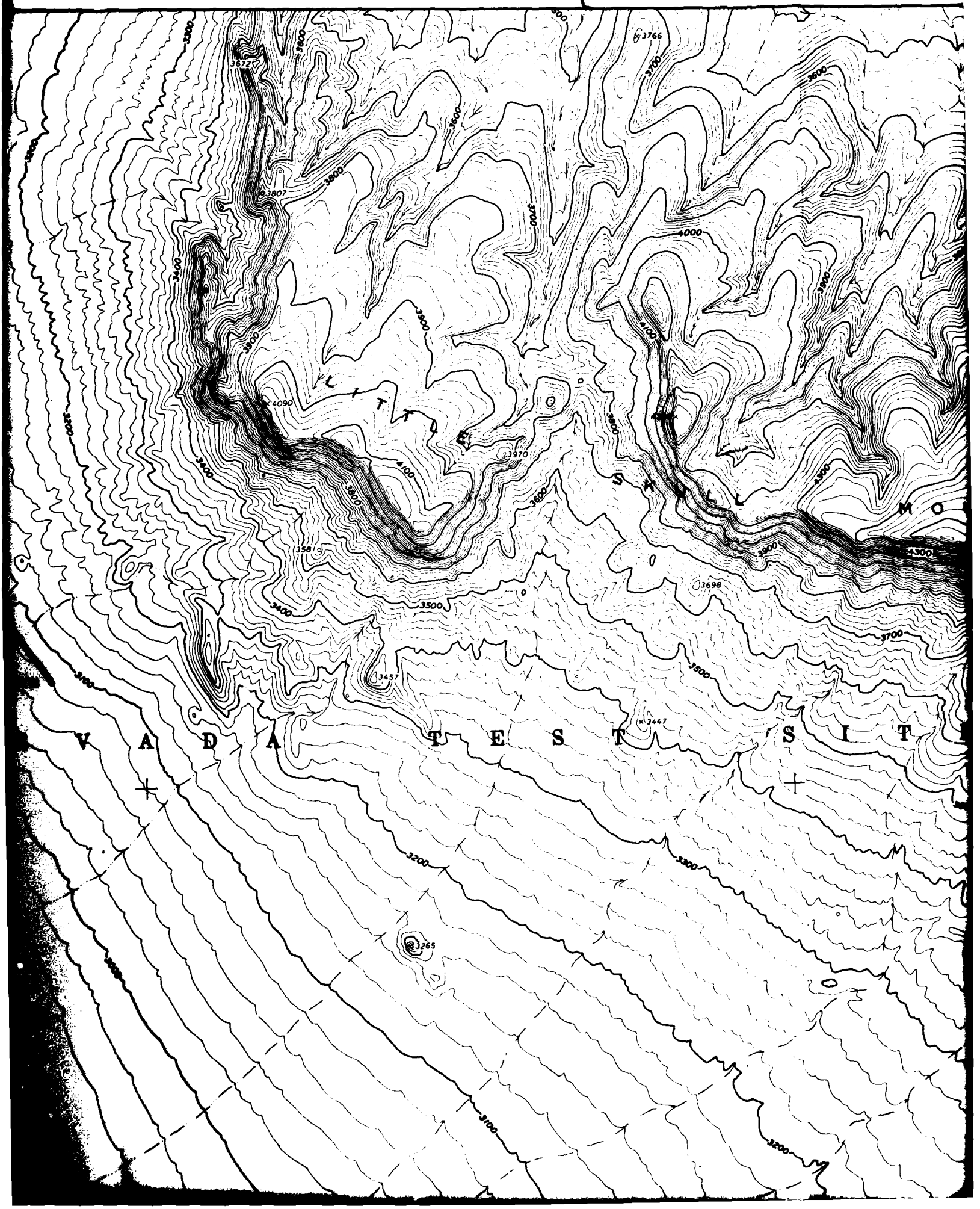
2901
2873
2840
2844
2828
2819
2800
Well
2867


Weather Station
BM 3044
Topopah Wash
3060
3000
3100
3200
BM 2987
3137
2960
2950
TEST TRACK G
TEST TRACK C
ROAD
3037
TEST TRACK B
BM 2929
E
2900
LATHROP WELLS ROAD
LOOP ROAD
SPRING
CANE
N E V A
Well 2867
VERTICAL SHELTER
BM 2867
3010
2840
BM 2822
E R S E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3677
3807
4090
3970
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3698
3457
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3265
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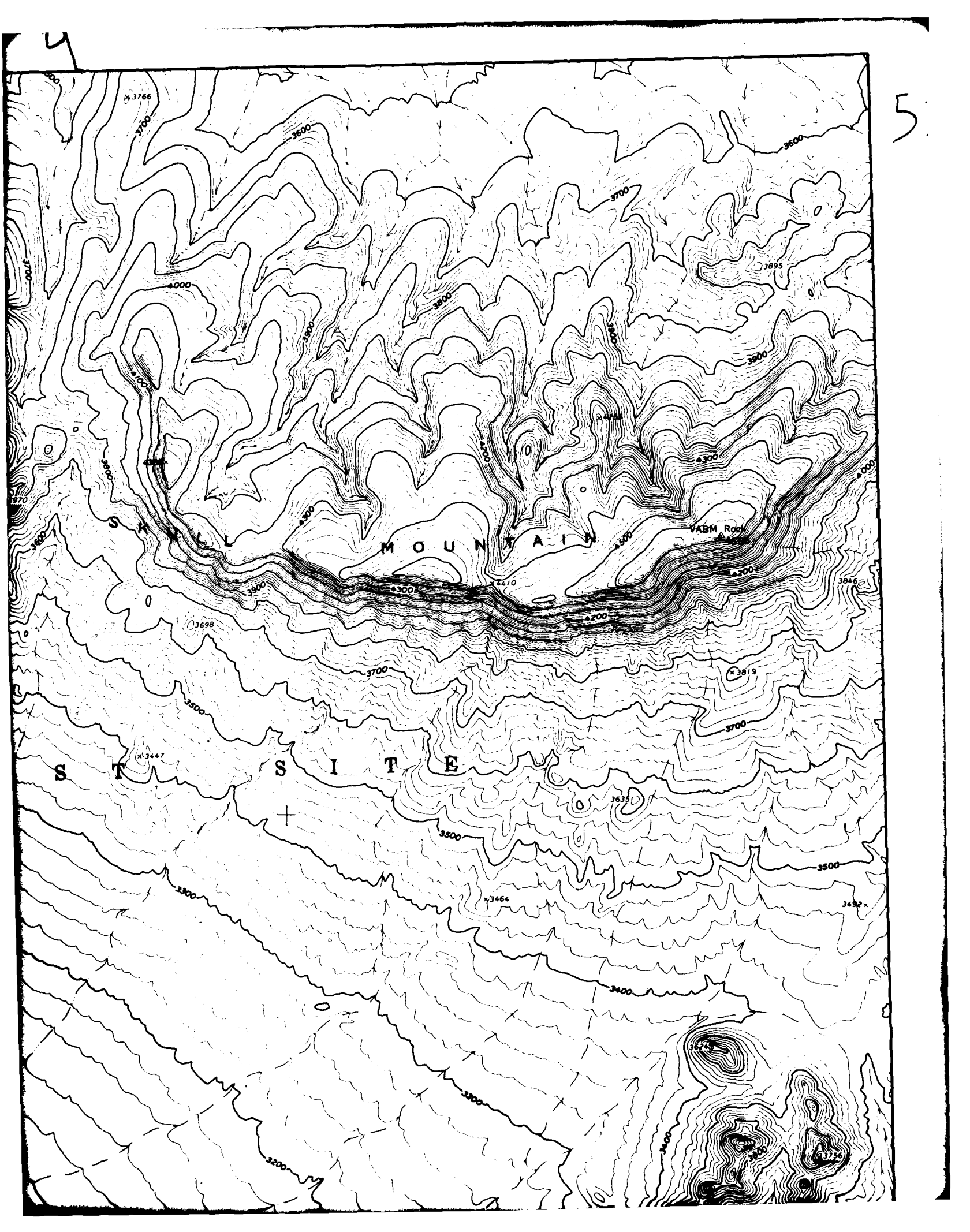
4000
4100
4300
V A D A
T E S T
S I T
M O


SHULL MOUNTAIN
VABM Rock
STATE SITE
3766
3895
4488
4410
3846
3698
3819
3447
3635
3464
3492
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4000
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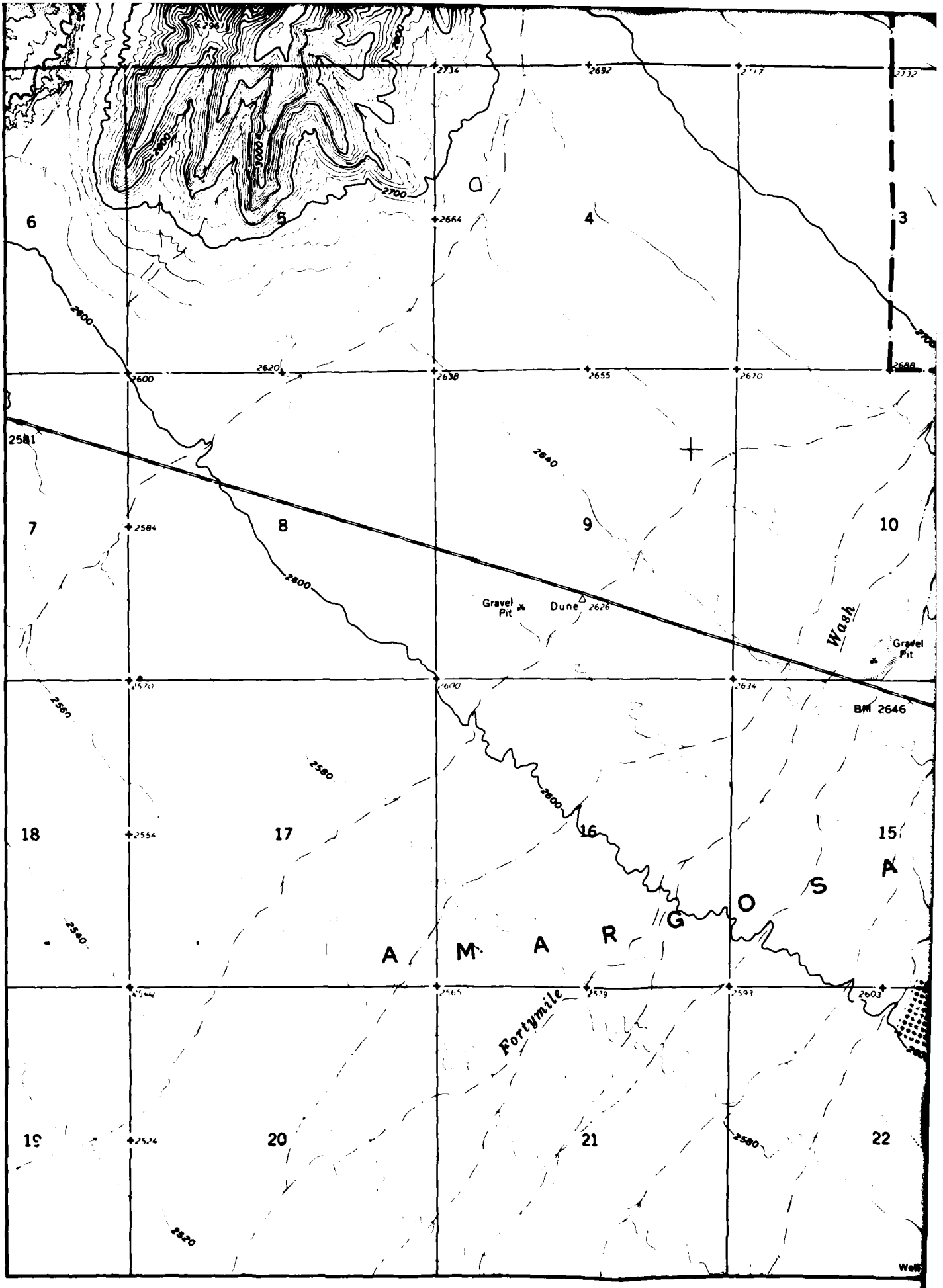
6
5
4
3
7
8
9
10
18
17
16
15
19
20
21
22
2734
2692
2664
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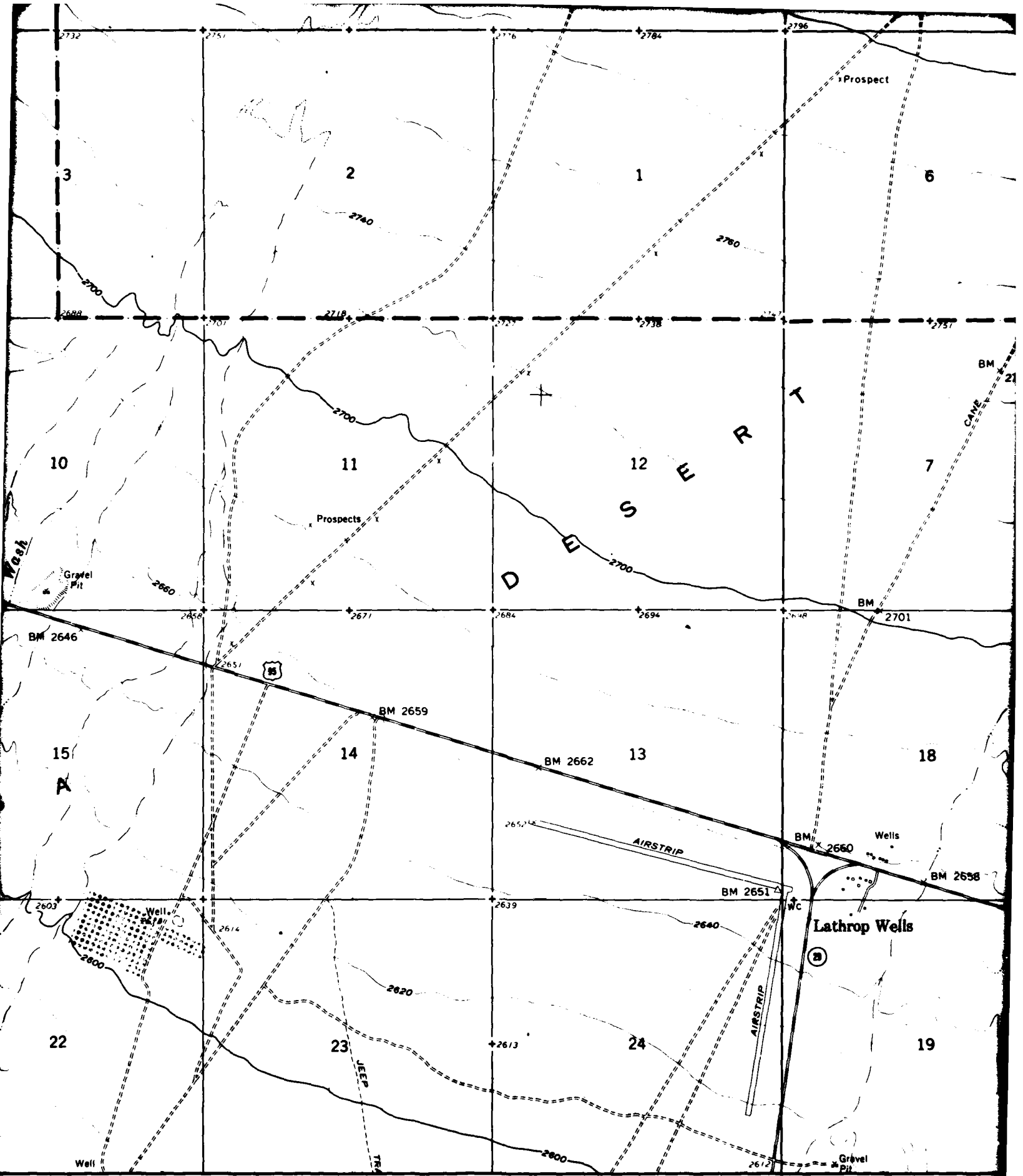
2638
2655
2670
2581
2584
2570
2690
2634
2554
2565
2579
2593
2603
2524
2600
2640
2560
2580
2820
Gravel Pit
Dune
2626
Wash
Gravel Pit
BM 2646
A M A R G O S A
Fortymile


Prospect
Prospects
Gravel Pit
Wash
DESERT
BM 2646
BM 2659
BM 2662
BM 2701
BM 2660
BM 2658
BM 2651
AIRSTRIP
AIRSTRIP
Wells
Well
Well
Gravel Pit
Lathrop Wells
JEEP
CANE
WC
95
95
2700
2660
2740
2760
2620
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2640
1
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7
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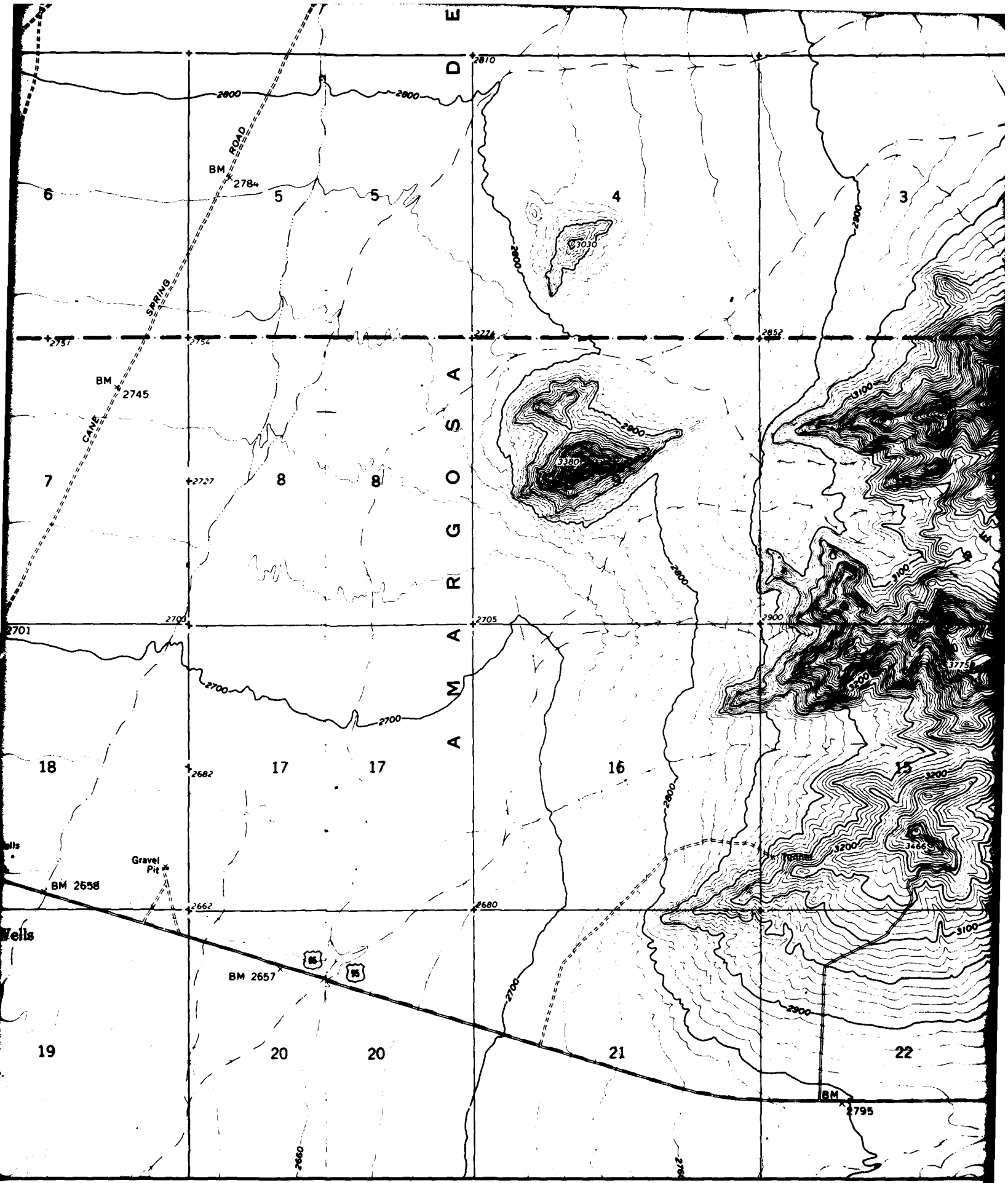
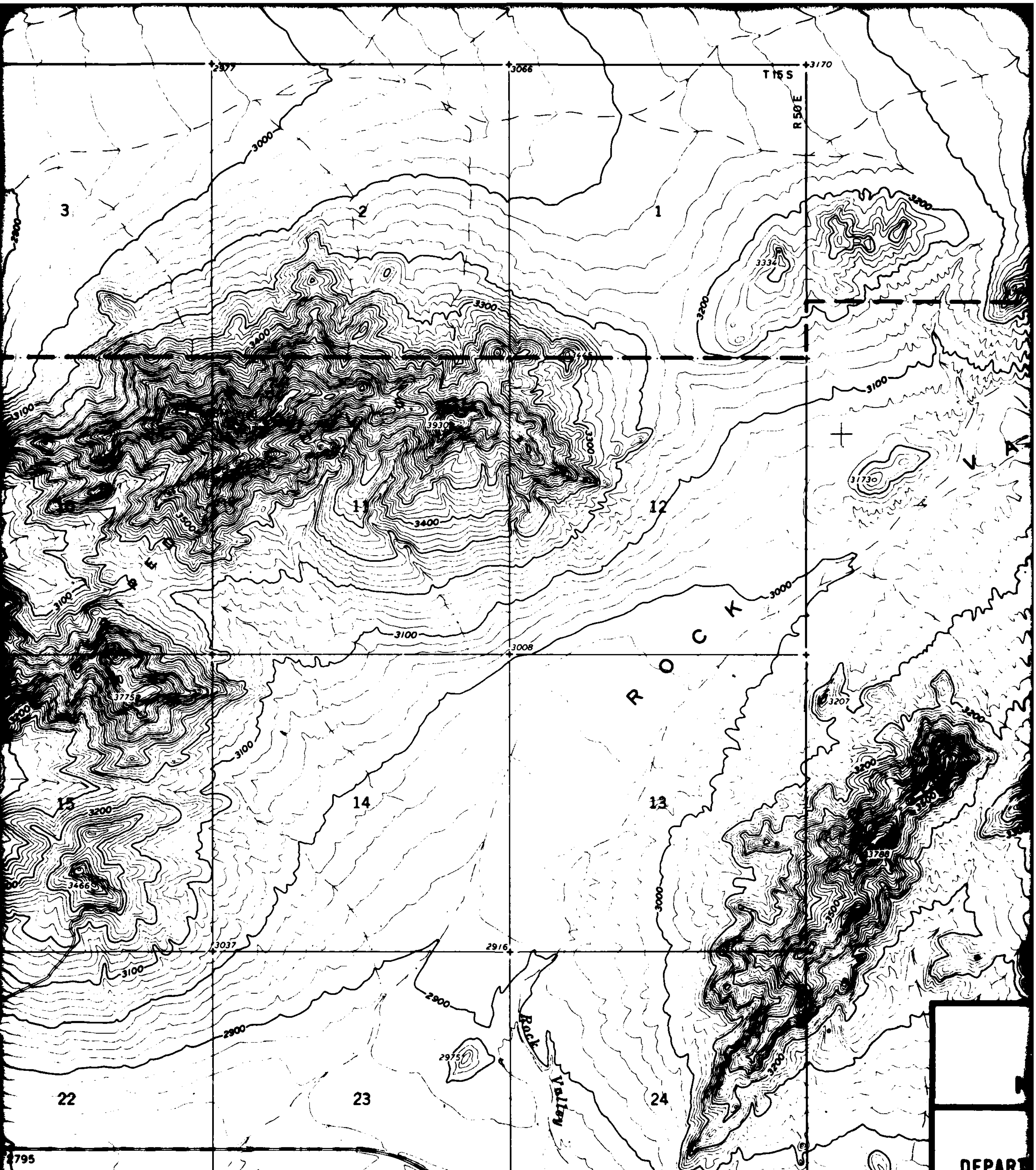

DEL AMARGOSA
ROAD
SPRING
CANE
BM 2784
BM 2745
BM 2658
BM 2657
BM 2795
Gravel Pit
Wells
6
5
4
3
7
8
18
17
16
15
19
20
21
22
2810
2800
2776
2852
2757
2754
2727
2701
2700
2705
2682
2662
2680
3030
3380
3100
3200
3775
3466
2660


T15S
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R O C K
Rock Valley Wash
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2795
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3400
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3788
2975
2900
3008
3037
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3066
3170

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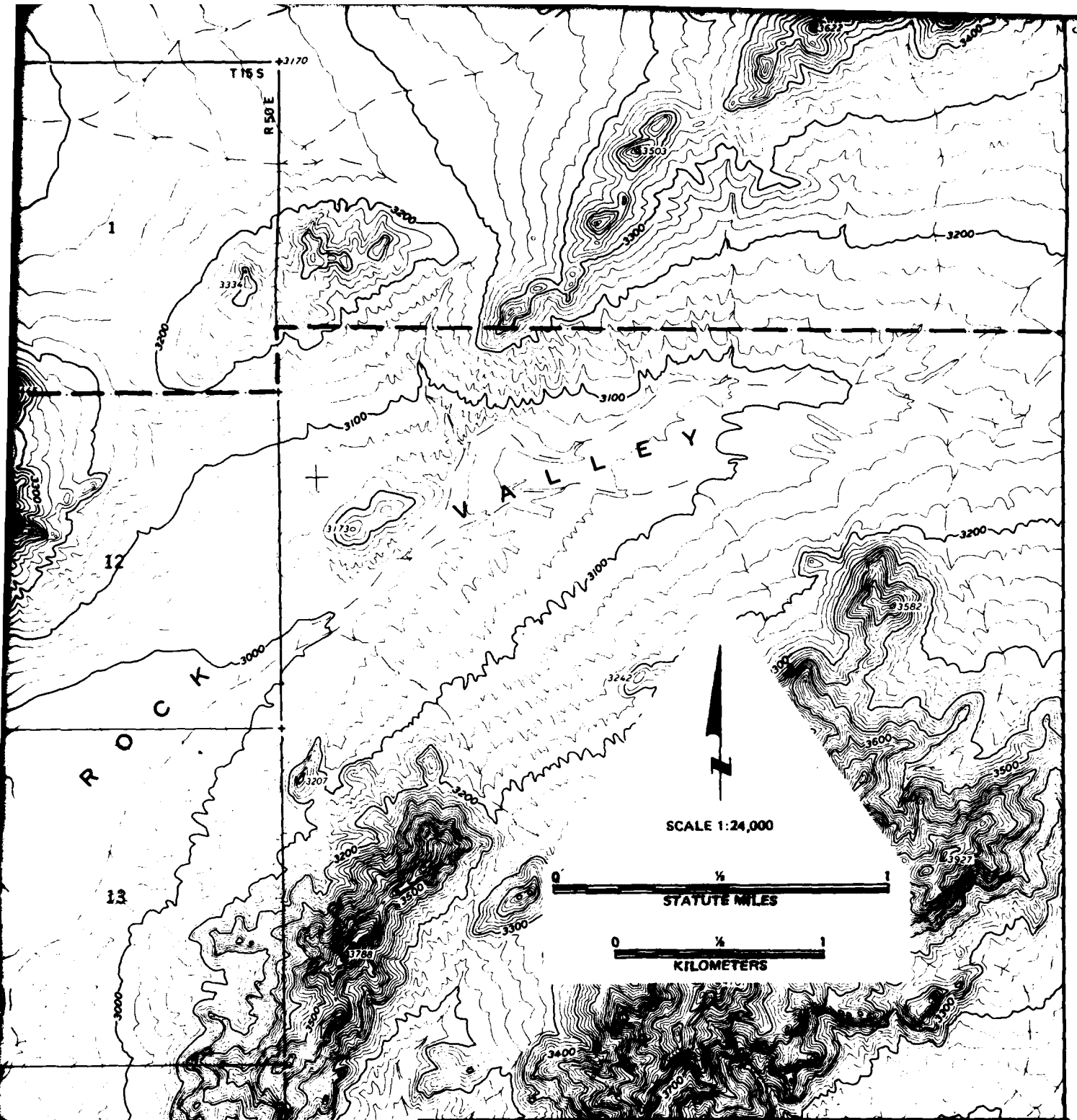


TOPOGRAPHIC MAP
ETB MOBILITY STUDY
NEVADA TEST SITE, NEVADA

MX SITING INVESTIGATION
DEPARTMENT OF THE AIR FORCE - BMO

Exhibit
2-1

FUGRO NATIONAL, INC.

10

2.2 TEST TRACK B

Test track B is located along the southwestern flank of the Little Skull Mountain (Figure 2-1). The underlying deposits consist of a thin mantle of young alluvial fan material (A5y) overlying intermediate-age alluvium (A5i). Test pit logs indicate that the soil is a gravelly sand (SP-SM and SW-SM). Stage I to III caliche, with local occurrences of Stage IV caliche, exist in this sand sometimes throughout the stratum or in the form of layers. This well-developed caliche, occurring at shallow depths, indicates that the uncemented younger alluvial fan deposit at the surface is very thin and is underlain by cemented intermediate alluvial fan material. Caliche development is somewhat more advanced than is generally encountered in the Nevada-Utah siting region, probably due to abundant local sources of calcium carbonate. Decomposition of basalt clasts in alluvium derived from the Little Skull Mountain and active eolian aggradation of calcareous dust on fan surfaces provide calcium carbonate needed for caliche formation.

2.3 TEST TRACK C

Test track C is located in the center of the valley adjacent to the Lathrop Wells Road and northeast of the prototype vertical shelter test bed (Figure 2-1). A thin mantle of poorly graded eolian sand (A3s) up to 5 feet thick overlies intermediate age alluvial fan deposits. Fortymile Wash has incised deeply into the intermediate fan surface indicating that the surface of the fan has been abandoned as a surface of material transport for a long period of time. A moderate to well-cemented caliche

horizon (Stage III and local occurences of Stage IV) occurs at the base of the eolian deposits. The source of calcium carbonate in this extensive caliche deposit is in part from calcareous dust and sand blowing northward from the Amargosa Desert and from basic volcanic rocks in the alluvium. This relatively abundant source of calcium carbonate resulted in accelerated development of caliche in the soil profile.

2.4 TEST TRACK G

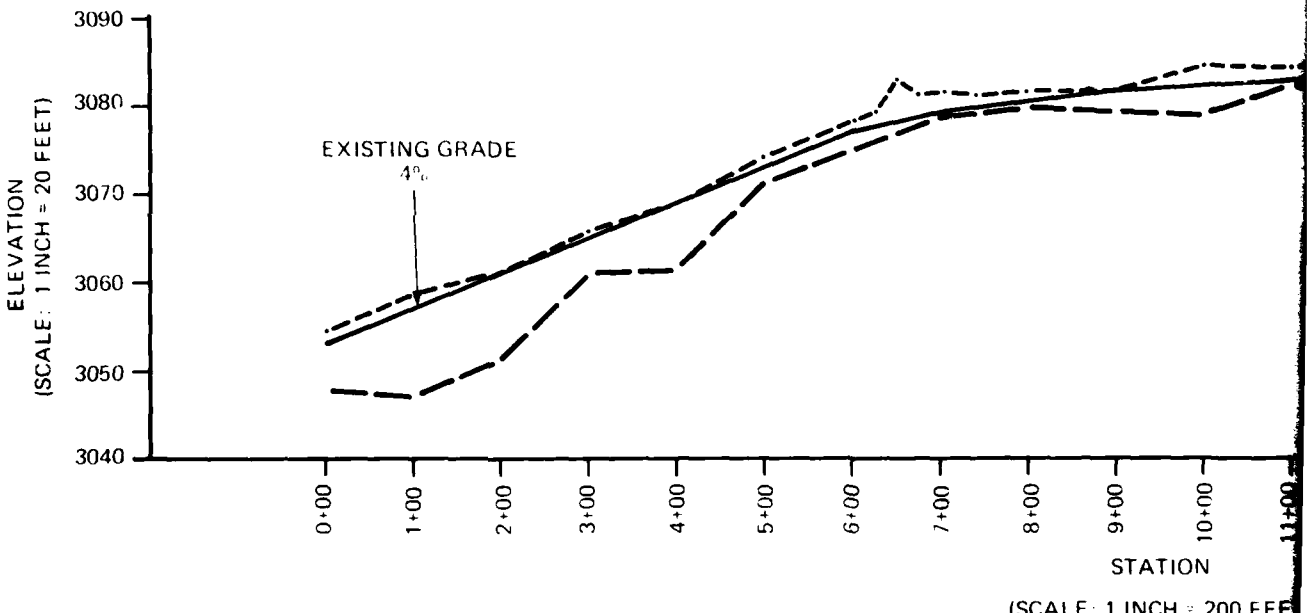
Test track G is located approximately 85 feet northeast of track C (see Figure 2-1). The geology is essentially the same for both tracks C and G.

3.0 FIELD INVESTIGATION

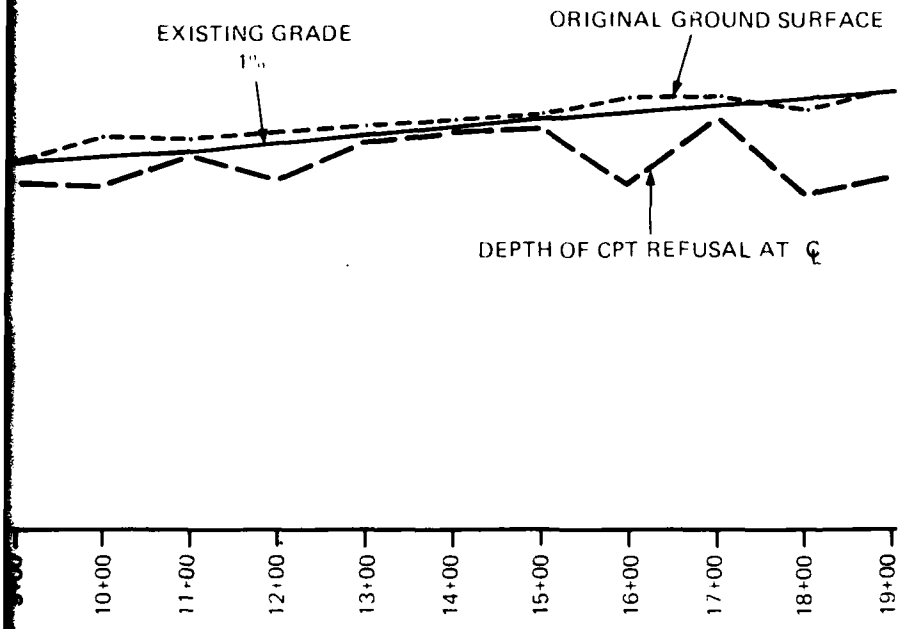
The first phase of the field investigation, consisting of test pits, field density and moisture content tests, and was performed for test tracks B and C between 28 April and 1 May 1980. The second phase of investigation (15 to 17 August 1980) was performed following mobility tests on track C. It consisted of CPTs at test track C, the newly constructed track G, and in the virgin desert (undisturbed ground) northeast of track G. The locations of the field activities are shown on Figures 3-1 through 3-3 and are summarized below:

Test Track or Location	Total Length (ft)	Activity	Total Number	Depth (ft)
B	1900	Test Pit	8	2.0 to 5.4
		In Situ Density and Moisture	9	—
		Disturbed Bulk Sample	14	—
		CPT	50	0.8 to 10.5
C	1200	Test Pit	4	3.5 to 6.0
		In Situ Density and Moisture	12	—
		Disturbed Bulk Sample	15	—
		CPT (pre-mobility testing)	42	3.8 to 6.4
		CPT (post-mobility testing)	42	2.6 to 5.5
G	1200	CPT (pre-mobility testing)	18	2.9 to 5.6
Virgin Desert	—	CPT	7	4.4 to 6.0

The methods of excavating test pits, sampling, and logging as well as performing in situ density and moisture content tests, were similar to those used presently in the ongoing MX Field Verification Program in Nevada and Utah valleys and are described in Appendix A. The CPTs were performed by the same equipment


EXIS
3090
3080
3070
3060
3050
3040
ELEVATION
(SCALE: 1 INCH = 20 FEET)
EXISTING GRADE
4%
0+00
1+00
2+00
3+00
4+00
5+00
6+00
7+00
8+00
9+00
10+00
11+00
STATION
(SCALE: 1 INCH = 200 FEE

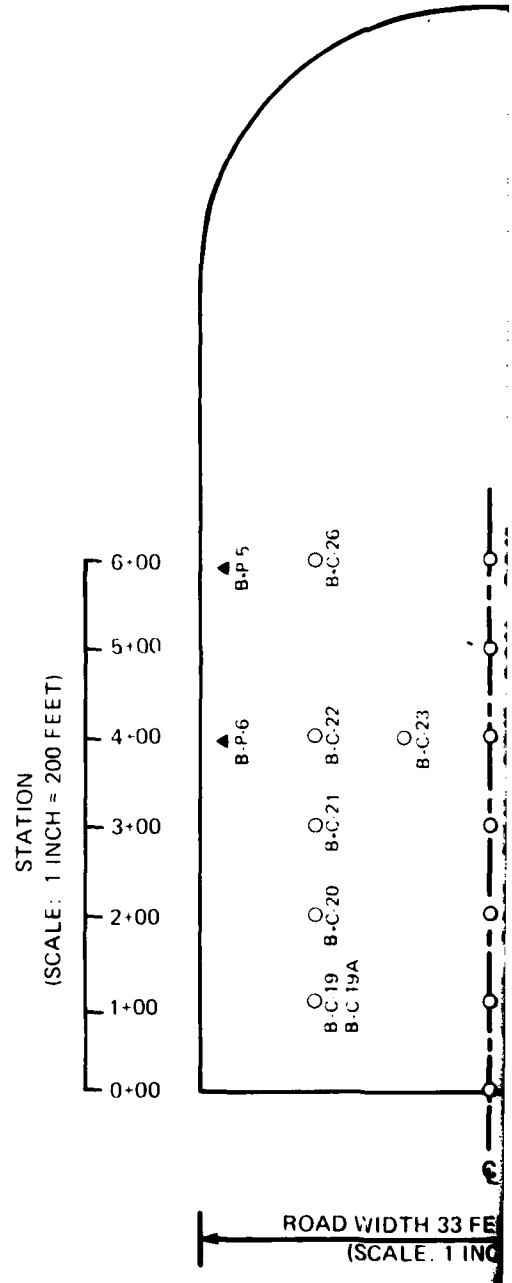
PROFILE

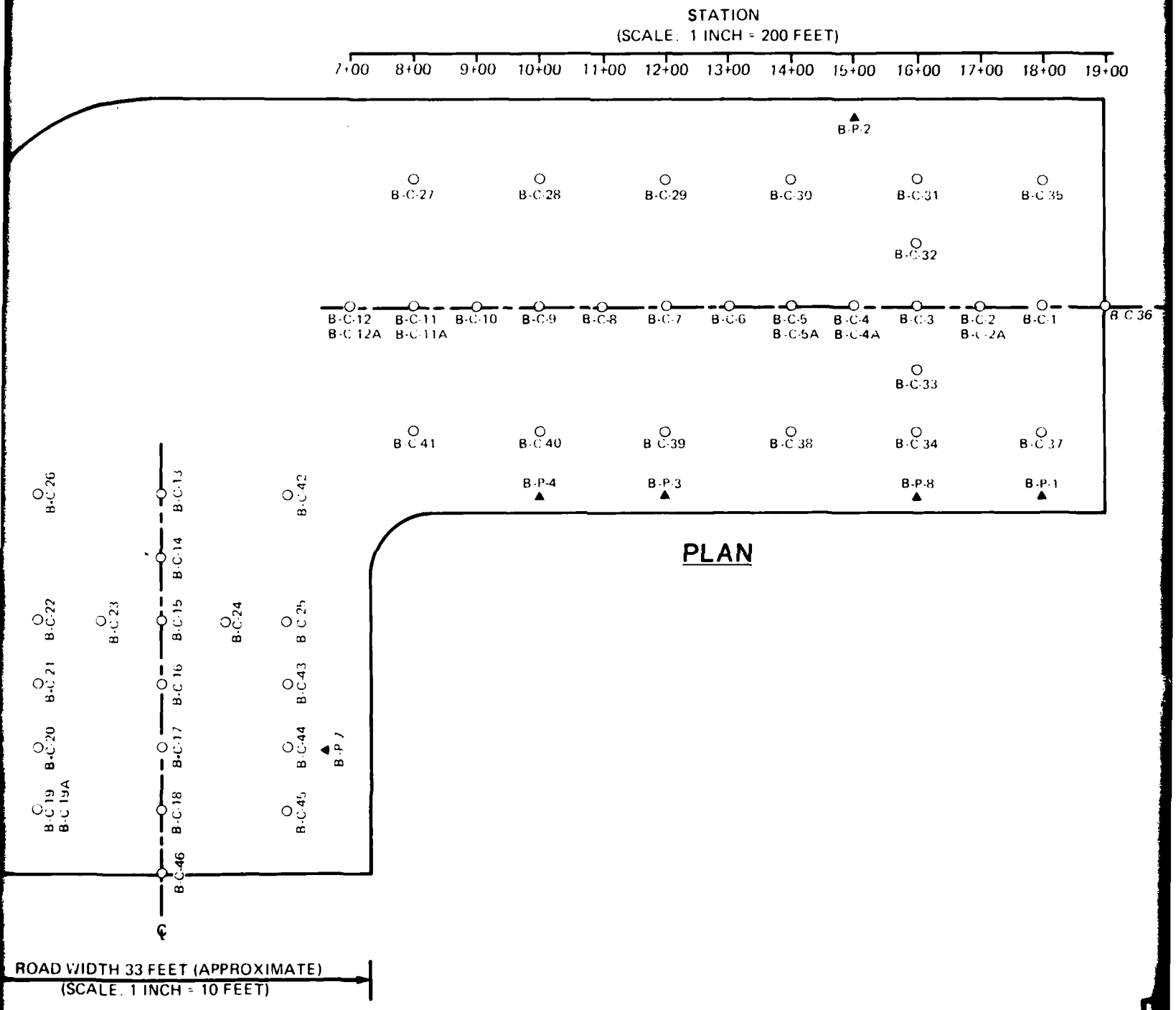


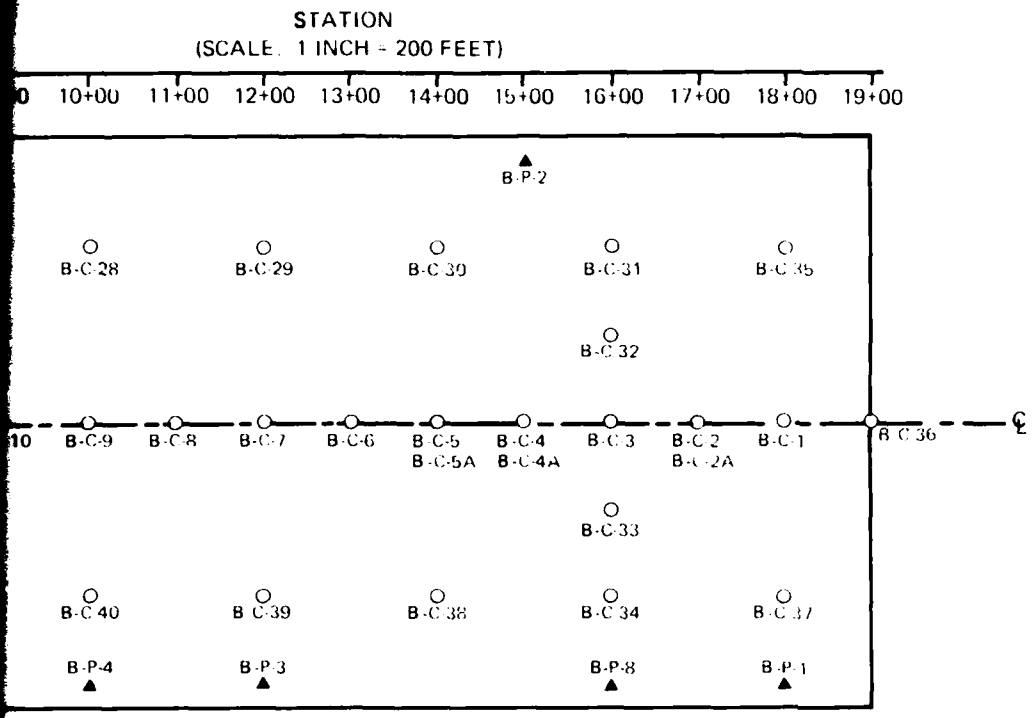
STATION

INCH - 200 FEET)

ROFILE




STATION
(SCALE. 1 INCH = 200 FEET)
7+00
8+00
9+00
10+00
11+00
12+00
13+00
14+00
15+00
16+00
17+00
18+00
19+00
B-P-2
B-C-27
B-C-28
B-C-29
B-C-30
B-C-31
B-C-35
B-C-32
B-C-12
B-C-12A
B-C-11
B-C-11A
B-C-10
B-C-9
B-C-8
B-C-7
B-C-6
B-C-5
B-C-5A
B-C-4
B-C-4A
B-C-3
B-C-2
B-C-2A
B-C-1
B-C-36
B-C-33
B-C-41
B-C-40
B-C-39
B-C-38
B-C-34
B-C-37
B-P-4
B-P-3
B-P-8
B-P-1
PLAN
B-C-26
B-C-13
B-C-42
B-C-14
B-C-22
B-C-23
B-C-15
B-C-24
B-C-25
B-C-21
B-C-16
B-C-43
B-C-20
B-C-17
B-C-44
B-P-7
B-C-19
B-C-19A
B-C-18
B-C-45
B-C-46
℄
ROAD WIDTH 33 FEET (APPROXIMATE)
(SCALE. 1 INCH = 10 FEET)



PLAN

EXPLANATION

▲ TEST PITS (P)

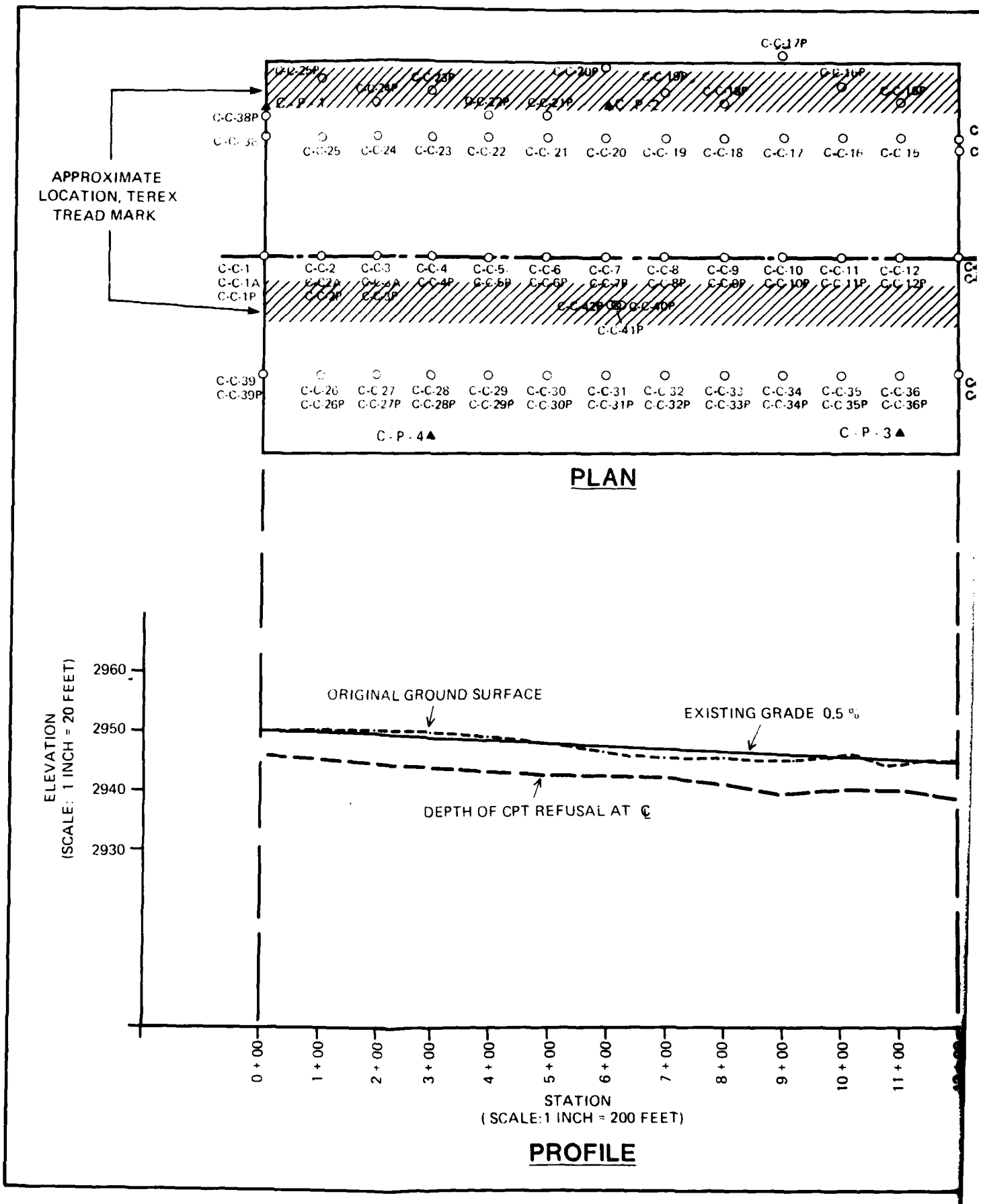
○ CONE PENETRATION TESTS (C)

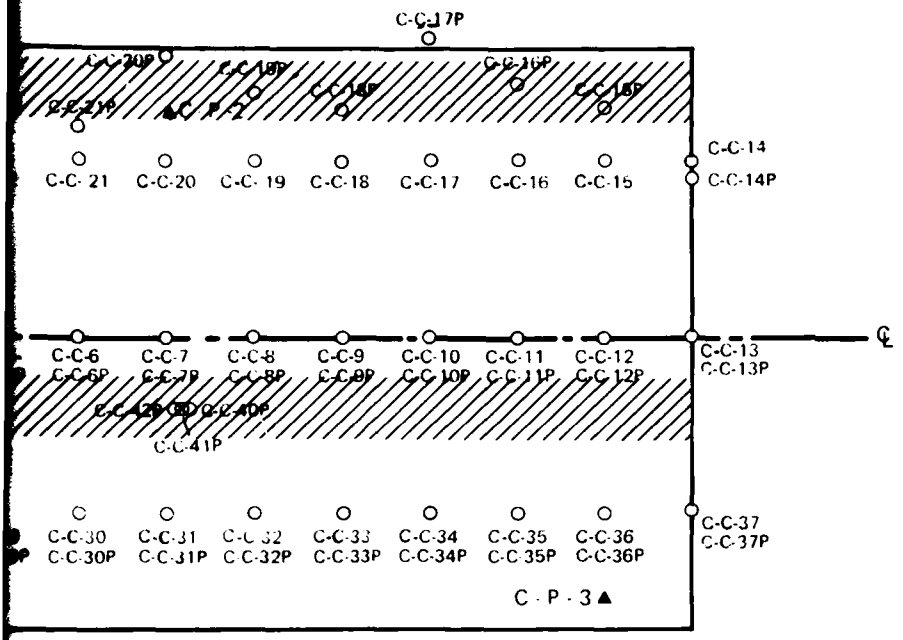
LOCATIONS OF FIELD ACTIVITIES AND PROFILE
TEST TRACK B, ETB MOBILITY STUDY
NEVADA TEST SITE, NEVADA

MX SITING INVESTIGATION
DEPARTMENT OF THE AIR FORCE BMO

FIGURE 31

FUGRO NATIONAL, INC.


APPROXIMATE LOCATION, TEREX TREAD MARK
C-C-38P
C-C-25
C-C-24
C-C-23
C-C-22
C-C-21
C-C-20
C-C-19
C-C-18
C-C-17
C-C-16
C-C-15
C-C-1
C-C-1A
C-C-1P
C-C-2
C-C-3
C-C-4
C-C-5
C-C-6
C-C-7
C-C-8
C-C-9
C-C-10
C-C-11
C-C-12
C-C-41P
C-C-39
C-C-39P
C-C-26
C-C-27
C-C-28
C-C-29
C-C-30
C-C-31
C-C-32
C-C-33
C-C-34
C-C-35
C-C-36
C-P-4
C-P-3
PLAN
ELEVATION (SCALE: 1 INCH = 20 FEET)
2960
2950
2940
2930
ORIGINAL GROUND SURFACE
EXISTING GRADE 0.5 %
DEPTH OF CPT REFUSAL AT ℄
0 + 00
1 + 00
2 + 00
3 + 00
4 + 00
5 + 00
6 + 00
7 + 00
8 + 00
9 + 00
10 + 00
11 + 00
STATION
(SCALE:1 INCH = 200 FEET)
PROFILE



ROAD WIDTH 33 FEET (APPROXIMATED)
(SCALE: 1 INCH = 10 FEET)

PLAN

RFACE

EXISTING GRADE 0.5 %

CPT REFUSAL AT ℄

5+00 6+00 7+00 8+00 9+00 10+00 11+00 12+00

STATION

CALE:1 INCH = 200 FEET)

PROFILE

EXPLANATION

▲ TEST PITS (P)

○ CONE PENETRATION TESTS (C)

EXAMPLE:

C-P-1 PRE-MOBILITY TEST CPT

C-P-1P POST MOBILITY TEST CPT

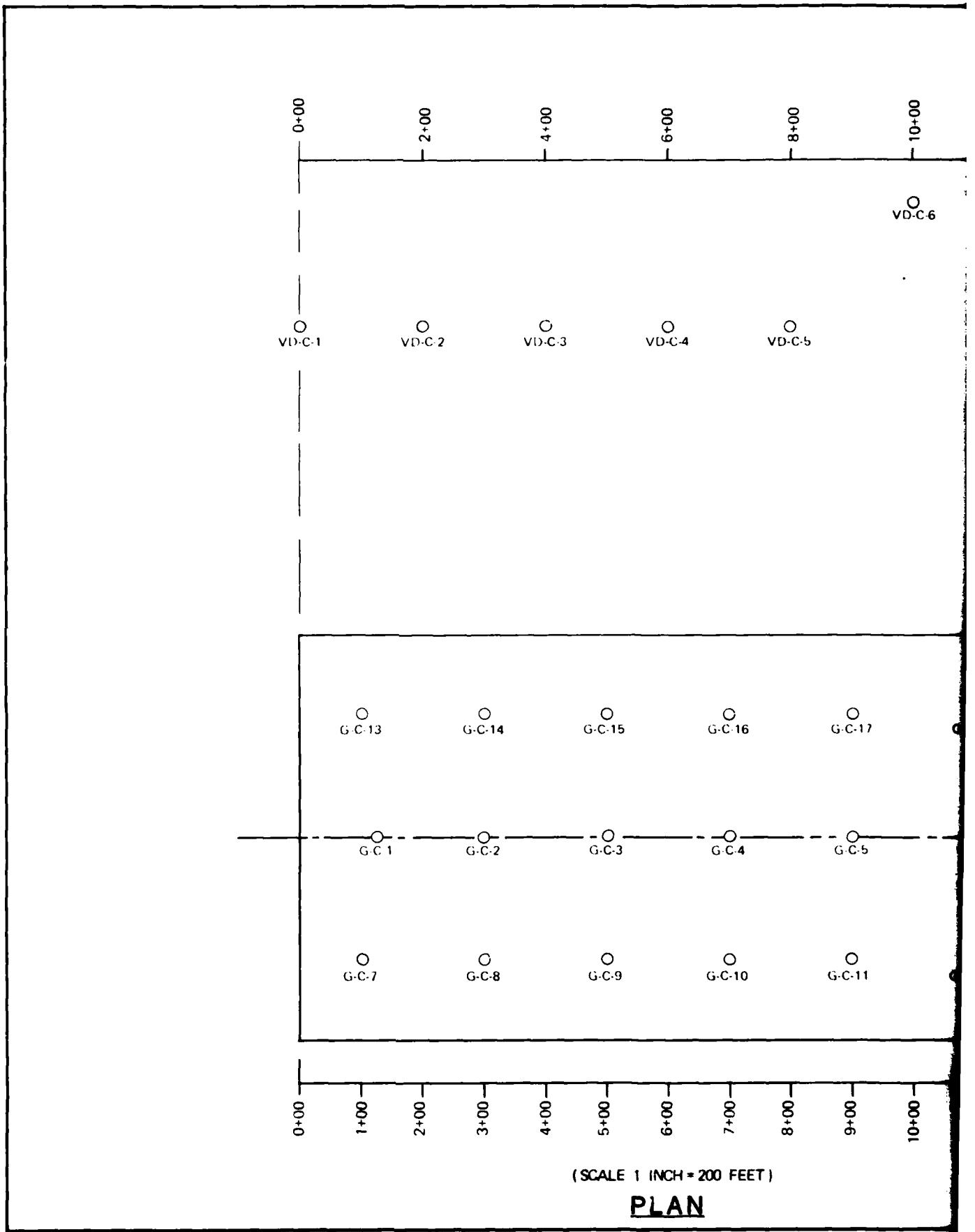
LOCATIONS OF FIELD ACTIVITIES AND PROFILE
TEST TRACK C, ETB MOBILITY STUDY
NEVADA TEST SITE, NEVADA

MX SITING INVESTIGATION
DEPARTMENT OF THE AIR FORCE - BMO

FIGURE 3-2

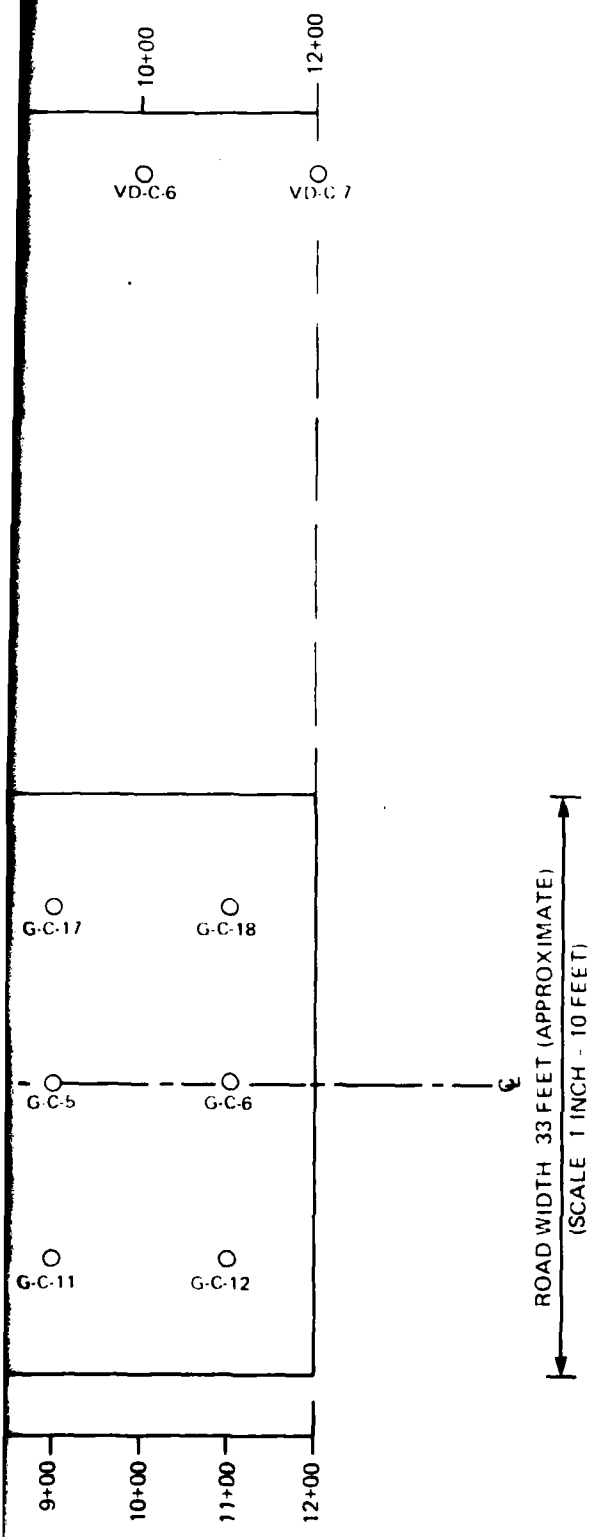
FUGRO NATIONAL, INC.

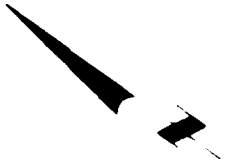
2



(SCALE 1 INCH = 200 FEET)

PLAN





EXPLANATION

○ CONE PENETRATION TESTS (C)

LOCATIONS OF FIELD ACTIVITIES
TEST TRACK G AND VIRGIN DESERT
ETB MOBILITY STUDY, NEVADA TEST SITE, NEVADA

MX SITING INVESTIGATION
DEPARTMENT OF THE AIR FORCE BMO

FIGURE 3-3

UGRO NATIONAL, INC.

used in the MX Field Verification Study. The equipment and method of cone penetration testing are described in Appendix B. The logs of the test pits and CPTs are included in Appendices A and B, respectively. The depths of the test pits and CPTs were limited by the capability of the equipment when they encountered the hard strata of caliche as shown in the profiles for test tracks B (Figure 3-1) and C (Figure 3-2).

The in situ density and moisture content test results are shown in Tables 3-1 and 3-2 for test tracks B and C, respectively. These tables also include the average cone end bearing resistance (q_c, tsf) from CPTs at the corresponding locations and depths of in situ density tests.

		INDIVIDUAL TEST RESULTS								RANGE OF RESULTS	AVERAGE
TEST PIT NUMBER		B-P-1	B-P-2	B-P-3	B-P-4	B-P-5	B-P-6	B-P-7	B-P-8		
CORRESPONDING CPT		B-C-37	B-C-4	B-C-39	B-C-40	B-C-26	B-C-22	B-C-44	B-C-34		
DEPTH INTERVAL (ft.)		[1.0–1.5]									
CATEGORY	γ_d (pcf)	115.9	—	113.5	105.2	114.5	—	109.6	99.9	99.9 – 115.9	109.8
	M/C (%)	8.0	—	7.0	4.8	7.0	—	5.4	4.7	4.7 – 8.0	6.2
	AVERAGE q_c (tsf)	330	—	300	260	450	—	260	550	260 – 550	358
DEPTH INTERVAL (ft.)		[2.0–2.5]									
CATEGORY	γ_d (pcf)	—	—	—	104.8	—	93.7	—	—	93.7 – 104.8	99.3
	M/C (%)	—	—	—	3.0	—	3.2	—	—	3.0 – 3.2	3.1
	AVERAGE q_c (tsf)	—	—	—	110	—	260	—	—	110 – 260	185
DEPTH INTERVAL (ft.)		[3.0–3.5]									
CATEGORY	γ_d (pcf)	—	—	—	112.1	—	—	—	—	112.1	112.1
	M/C (%)	—	—	—	2.0	—	—	—	—	2.0	2.0
	AVERAGE q_c (tsf)	—	—	—	265	—	—	—	—	265	265

EXPLANATION

γ_d DRY DENSITY

M/C MOISTURE CONTENT

q_c CONE END BEARING RESISTANCE

FIELD TEST RESULTS
TEST TRACK 8, ETB MOBILITY STUDY
NEVADA TEST SITE , NEVADA

MX SITING INVESTIGATION
DEPARTMENT OF THE AIR FORCE - BMO

TABLE 3-1

FUGRO NATIONAL, INC.

		INDIVIDUAL TEST RESULTS				RANGE OF RESULTS	AVERAGE
TEST PIT NUMBER		C-P-1	C-P-2	C-P-3	C-P-4		
CORRESPONDING CPT NUMBER		C-C-38	C-C-20	C-C-36	C-C-28		
DEPTH INTERVAL (ft.)		[1.0–1.5]					
CATEGORY	γ_d (pcf)	110.2	105.0	108.5	97.9	97.9 ~ 110.2	105.4
	M/C (%)	4.9	5.0	5.6	5.8	4.9–5.8	5.3
	AVERAGE q_c (tsf)	90	140	110	100	90~140	110
DEPTH INTERVAL (ft.)		[2.0–2.5]					
CATEGORY	γ_d(pcf)	108.4	107.6	100.0	104.8	100.0 ~ 108.4	105.2
	M/C (%)	6.7	5.7	6.1	6.3	5.7~6.7	6.2
	AVERAGE q_c (tsf)	90	160	100	110	90~160	115
DEPTH INTERVAL (ft.)		[3.0–3.5]					
CATEGORY	γ_d(pcf)	108.5	107.8	107.4	112.0	107.8 ~ 112.0	108.9
	M/C (%)	7.6	6.8	5.9	6.0	5.9~7.6	6.6
	AVERAGE q_c (tsf)	250	105	80	125	80~250	140

EXPLANATION

γ_d DRY DENSITY

M/C MOISTURE CONTENT

q_c CONE END BEARING RESISTANCE

FIELD TEST RESULTS
TEST TRACK C, ETB MOBILITY STUDY
NEVADA TEST SITE, NEVADA

MX SITING INVESTIGATION
DEPARTMENT OF THE AIR FORCE - BMO

TABLE 3-2

UGRO NATIONAL, INC.

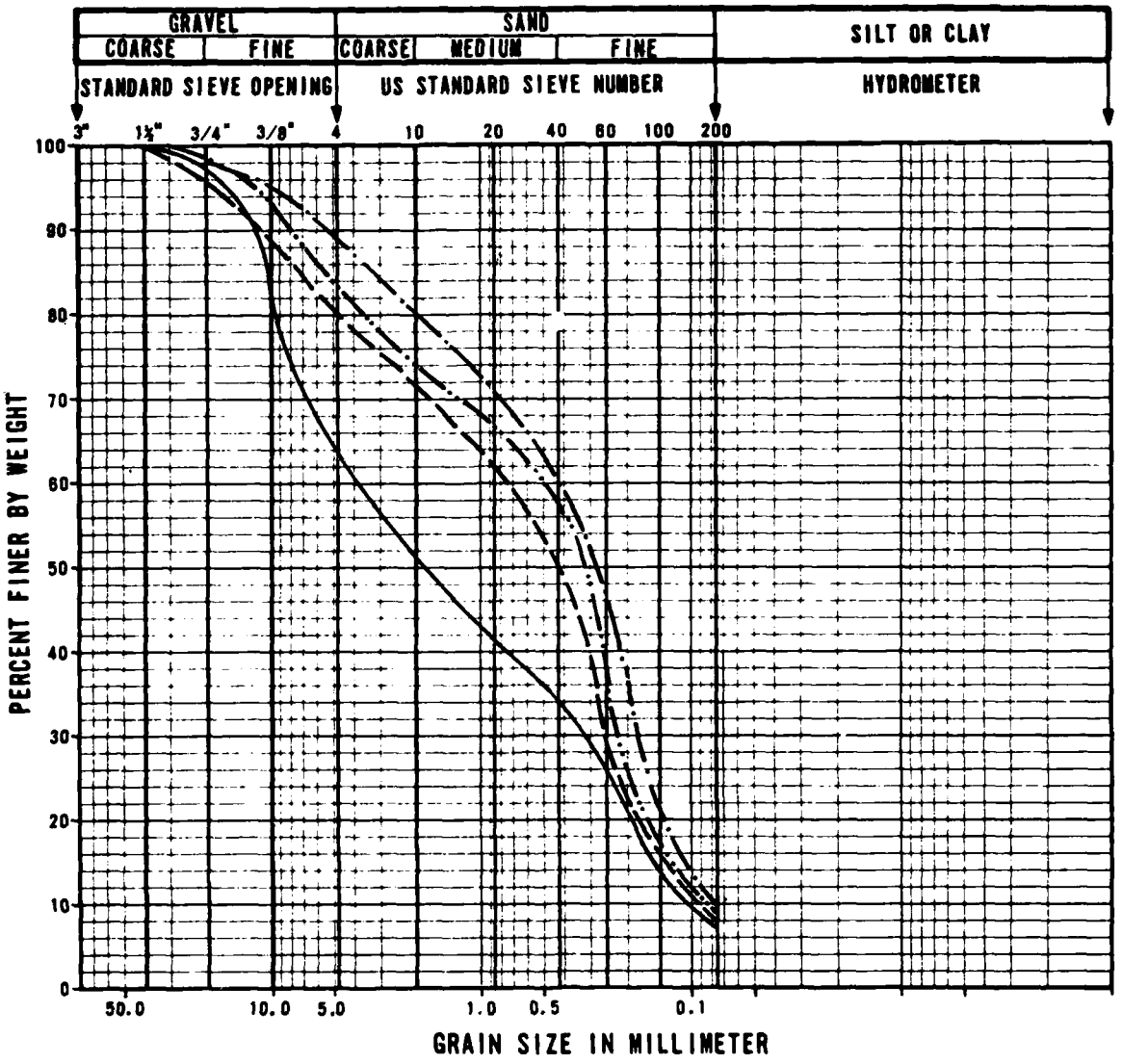
4.0 LABORATORY INVESTIGATION

Laboratory tests were performed on soil samples obtained from the test pits excavated in test tracks B and C during the first phase of field investigation. The tests consisted of: classification, compaction, relative density, CBR, and triaxial compression. The number of tests performed is summarized below:

TEST	NUMBER OF TESTS	
	Test Track B	Test Track C
Sieve Analysis	8	11
Atterberg Limits	10	1
Specific Gravity	5	3
Compaction	3	2
Relative Density	3	3
CBR	4	2
Triaxial Compression	2	1

The test procedures generally conformed to those of the American Society for Testing and Materials (ASTM) standards. In the relative density tests, both dry and wet methods were used to determine the maximum and minimum dry densities. In the CBR tests, the samples were compacted at both field and optimum moisture contents. However, only the samples compacted at optimum moisture content were soaked before performing the penetration tests. In the triaxial compression tests, the samples compacted at both field and optimum moisture contents to different densities were used.

The grain size distribution curves of soil samples from track B are shown in Figure 4-1. The results of relative density, CBR, and triaxial compression tests are presented in Table 4-1 and Figures 4-2 through 4-4, respectively.



SYMBOL	SAMPLE NUMBER	SAMPLE INTERVAL		SOIL TYPE
		FEET	METERS	
——	B–P–4 (B–1)	1.0–2.0	0.30–0.61	SP–SM
— —	B–P–6 (B–1)	1.0–2.0	0.30–0.61	SP–SM
—·—	B–P–7 (B–1)	1.0–2.0	0.30–0.61	SP–SM
—··—	B–P–8 (B–1)	1.0–2.0	0.30–0.61	SP–SM

GRAIN SIZE CURVES
TEST TRACK B, ETB MOBILITY STUDY
NEVADA TEST SITE, NEVADA

MX SITING INVESTIGATION
DEPARTMENT OF THE AIR FORCE - BMO

FIGURE
4-1

FUGRO NATIONAL, INC.

USAF–10

MAXIMUM DRY DENSITY, pcf				MINIMUM DRY DENSITY, pcf	
WET METHOD		DRY METHOD		DRY METHOD	
RANGE	AVERAGE	RANGE	AVERAGE	RANGE	AVERAGE
100.0 ~ 128.6	117.6 (5)	112.6 ~ 120.4	115.9 (6)	91.4 ~ 101.1	96.0 (9)
COMPOSITE AVERAGE = 116.7					

NOTES: 1. THE ABOVE DATA IS OBTAINED FROM 3 TYPICAL SAMPLES: B-P-4 (B-1)
B-P-6 (B-1)
B-P-7 (B-1)

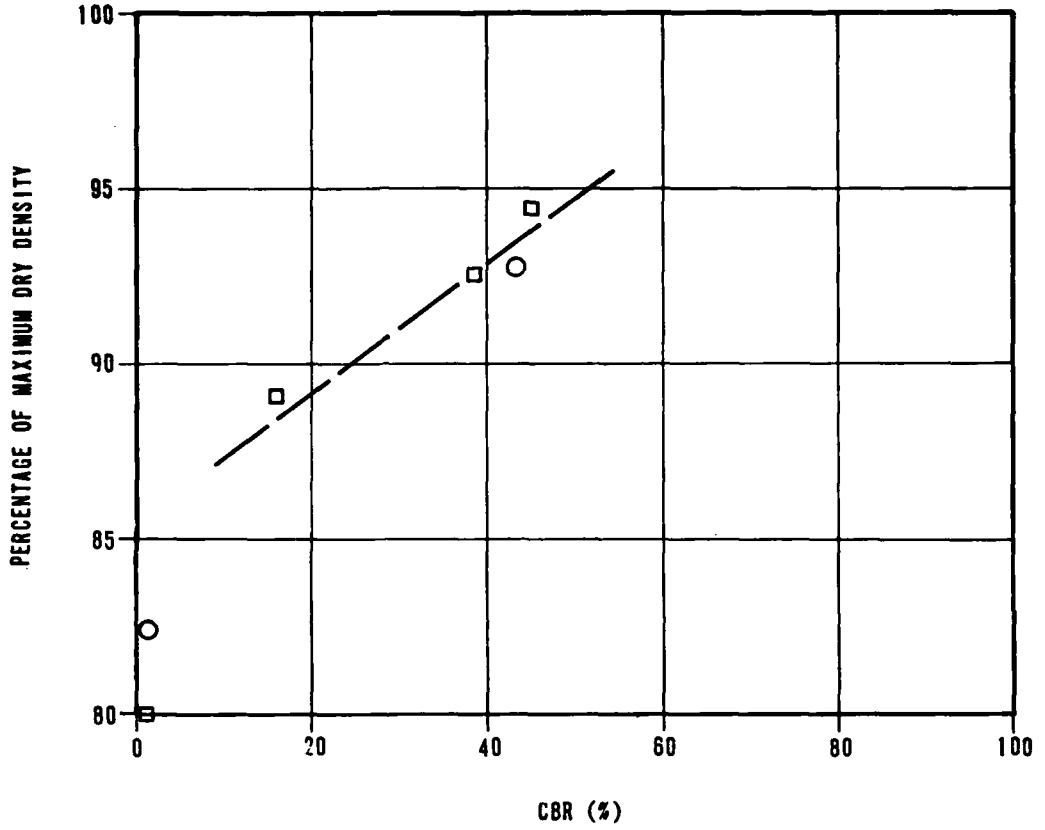
2. THE NUMBERS IN PARENTHESES REPRESENT THE NUMBER OF TESTS.

RELATIVE DENSITY RESULTS
TEST TRACK B, ETB MOBILITY STUDY
NEVADA TEST SITE, NEVADA

MX SITING INVESTIGATION
DEPARTMENT OF THE AIR FORCE - BMO

TABLE 4-1

FUGRO NATIONAL, INC.



SYMBOL	SAMPLE NUMBER	MOISTURE CONTENT AS TESTED (%)
○	B-P-4 (B-1)	OPTIMUM
□	B-P-7 (B-1)	OPTIMUM

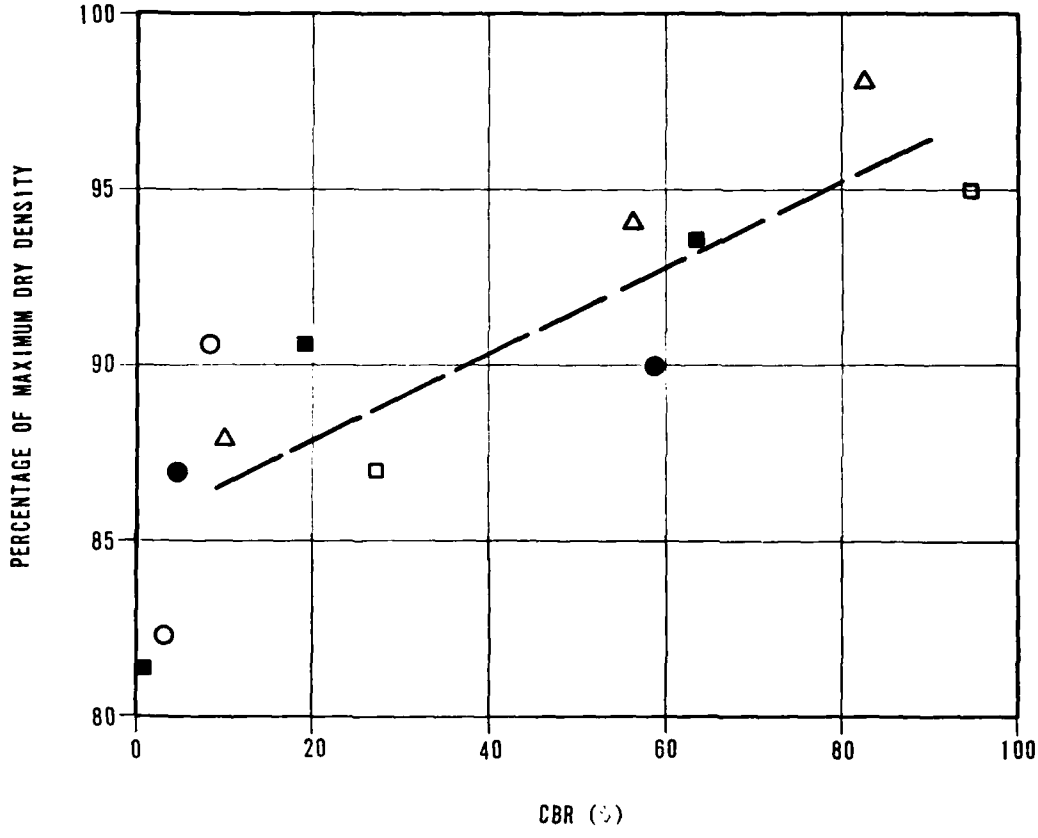
CALIFORNIA BEARING RATIO (CBR) CURVE
SOAKED TESTS, TEST TRACK B
ETB MOBILITY STUDY
NEVADA TEST SITE, NEVADA

MX SITING INVESTIGATION
DEPARTMENT OF THE AIR FORCE - BMO

FIGURE 4-2

UGRO NATIONAL, INC.

USA F-07



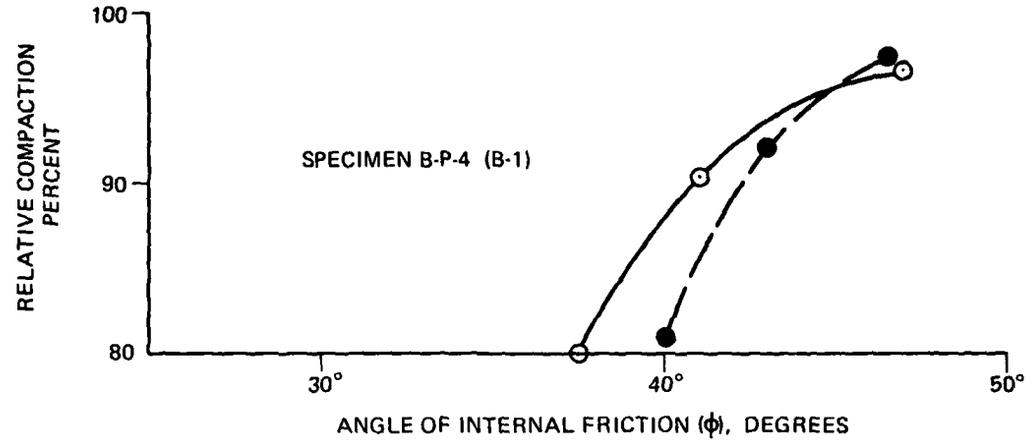
SYMBOL	SAMPLE NUMBER	MOISTURE CONTENT AS TESTED (%)
○	B-P-4 (B-1)	2.4, 2.2
●	B-P-4 (B-1)	5.0, 5.2
△	B-P-6 (B-1)	4.8, 4.9, 5.0
□	B-P-7 (B-1)	6.0, 6.1
■	B-P-8 (B-1)	2.9, 2.9, 2.8

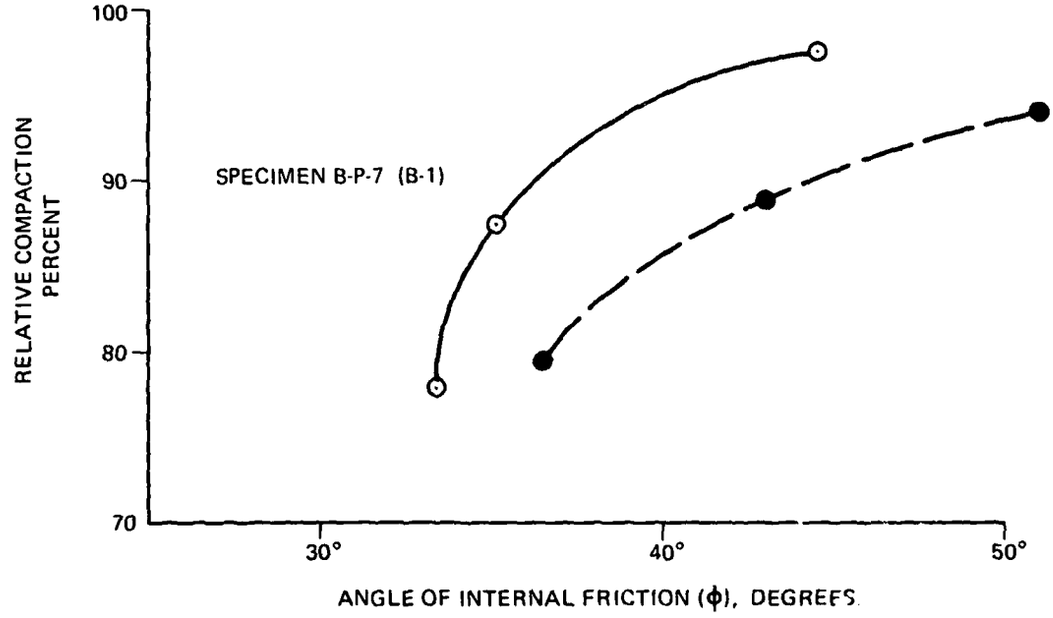
CALIFORNIA BEARING RATIO (CBR) CURVE
UNSOAKED TESTS. TEST TRACK B
ETB MOBILITY STUDY
NEVADA TEST SITE, NEVADA

MX SITING INVESTIGATION
DEPARTMENT OF THE AIR FORCE BMO

FIGURE 4-3

FUGRO NATIONAL, INC.





EXPLANATION

○ SPECIMEN WITH OPTIMUM MOISTURE CONTENT

● SPECIMEN WITH 3% MOISTURE CONTENT

TRIAXIAL COMPRESSION TEST RESULTS
TEST TRACK B, ETB MOBILITY STUDY
NEVADA TEST SITE, NEVADA

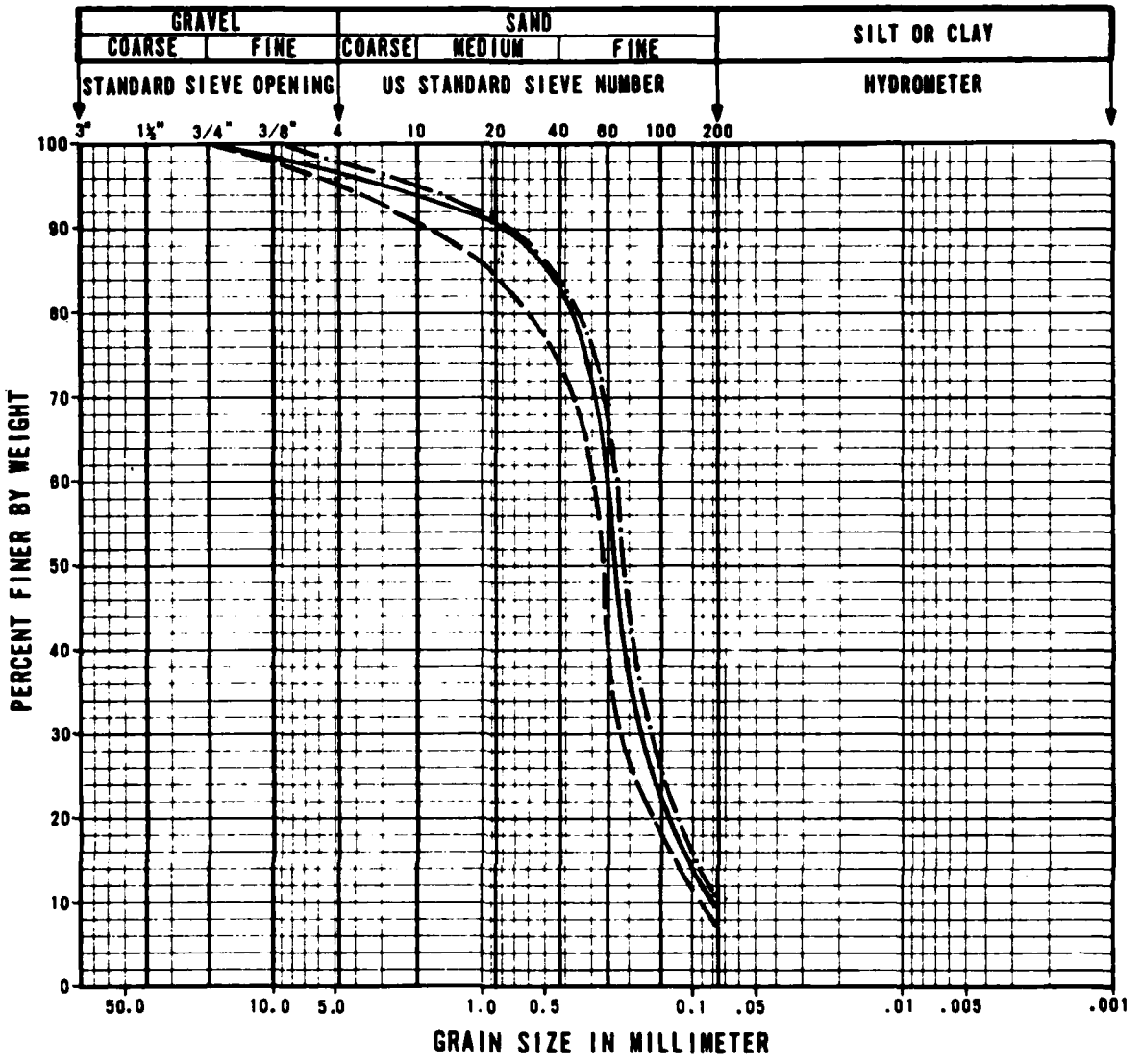
MX SITING INVESTIGATION
DEPARTMENT OF THE AIR FORCE - BMO

FIGURE 4-4

FUGRO NATIONAL, INC.

The grain size distribution curves of soil samples from track C are shown in Figure 4-5. The results of relative density, CBR, and triaxial compression tests are presented in Table 4-2 and Figures 4-5 through 4-8,respectively.

Detailed laboratory test results are presented in Appendix C.



SYMBOL	SAMPLE NUMBER	SAMPLE INTERVAL		SOIL TYPE
		FEET	METERS	
——	C-P-1 (B-1)	1.0–3.0	0.30–0.91	SP–SM
— —	C-P-2 (B-1)	1.0–2.0	0.30–0.61	SP–SM
—·—	C-P-3 (B-3)	3.0–5.0	0.91–1.52	SP–SM

GRAIN SIZE CURVES
TEST TRACK C, ETB MOBILITY STUDY
NEVADA TEST SITE, NEVADA

MX SITING INVESTIGATION
DEPARTMENT OF THE AIR FORCE - BMO

FIGURE 4-5

FUGRO NATIONAL, INC.

USAF-10

MAXIMUM DRY DENSITY, pcf				MINIMUM DRY DENSITY, pcf	
WET METHOD		DRY METHOD		DRY METHOD	
RANGE	AVERAGE	RANGE	AVERAGE	RANGE	AVERAGE
99.3 ~ 111.1	107.2 (6)	103.4 ~ 115.3	109.4 (17)	84.3 ~ 98.4	90.1 (12)
COMPOSITE AVERAGE = 108.8					

NOTES: 1. THE ABOVE DATA IS OBTAINED FROM 3 TYPICAL SAMPLES: C-P-1 (B-1)
C-P-2 (B-1)
C-P-3 (B-1)

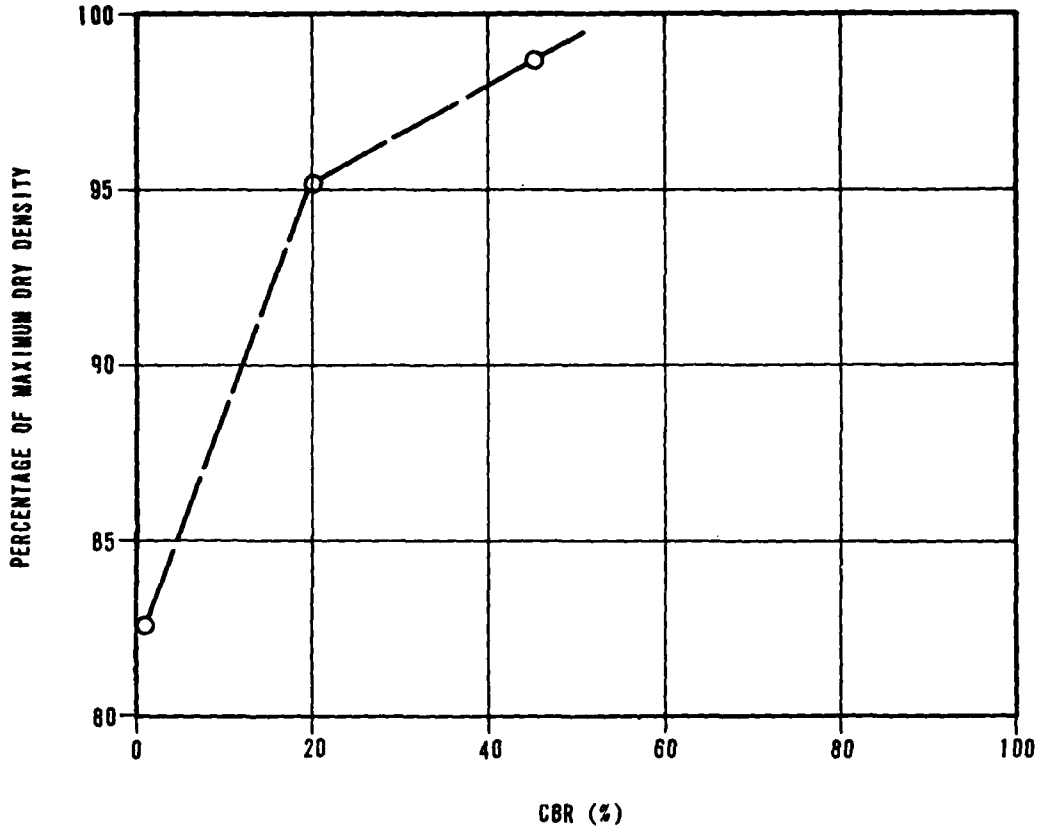
2. THE NUMBERS IN PARENTHESES REPRESENT THE NUMBER OF TESTS.

RELATIVE DENSITY RESULTS
TEST TRACK C, ETB MOBILITY STUDY
NEVADA TEST SITE, NEVADA

MX SITING INVESTIGATION
DEPARTMENT OF THE AIR FORCE - BMO

TABLE 4-2

UGRO NATIONAL, INC.



SYMBOL	SAMPLE NUMBER	MOISTURE CONTENT AS TESTED (%)
O	C-P-3 (B-3)	OPTIMUM

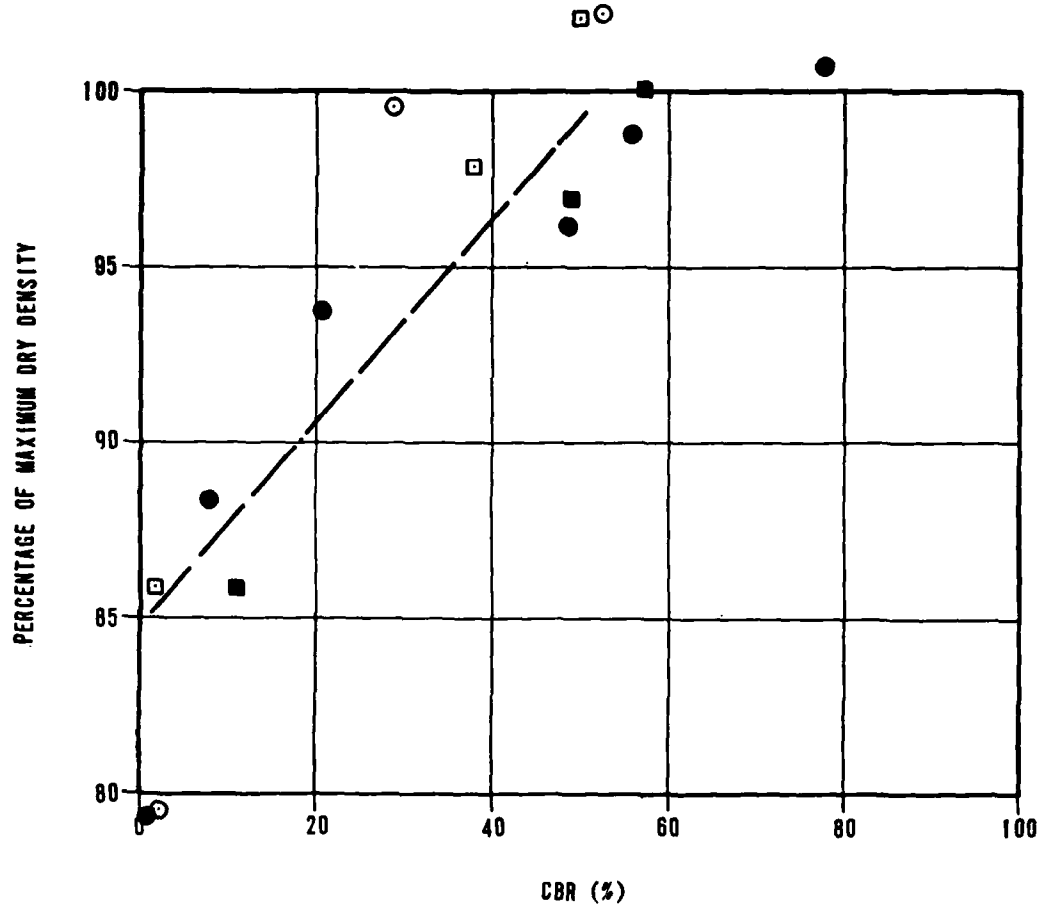
CALIFORNIA BEARING RATIO (CBR) CURVE
SOAKED TESTS. TEST TRACK C
ETB MOBILITY STUDY
NEVADA TEST SITE, NEVADA

MX SITING INVESTIGATION
DEPARTMENT OF THE AIR FORCE - BMO

FIGURE 4-6

FUGRO NATIONAL, INC.

USAF-07



SYMBOL	SAMPLE NUMBER	MOISTURE CONTENT AS TESTED (%)
⊙	C-P-1 (B-1)	5.2, 5.3, 5.2
⊡	C-P-1 (B-1)	6.8, 6.8, 6.9
●	C-P-3 (B-1)	5.4, 5.6, 5.0
■	C-P-3 (B-1)	6.6, 6.8, 6.7

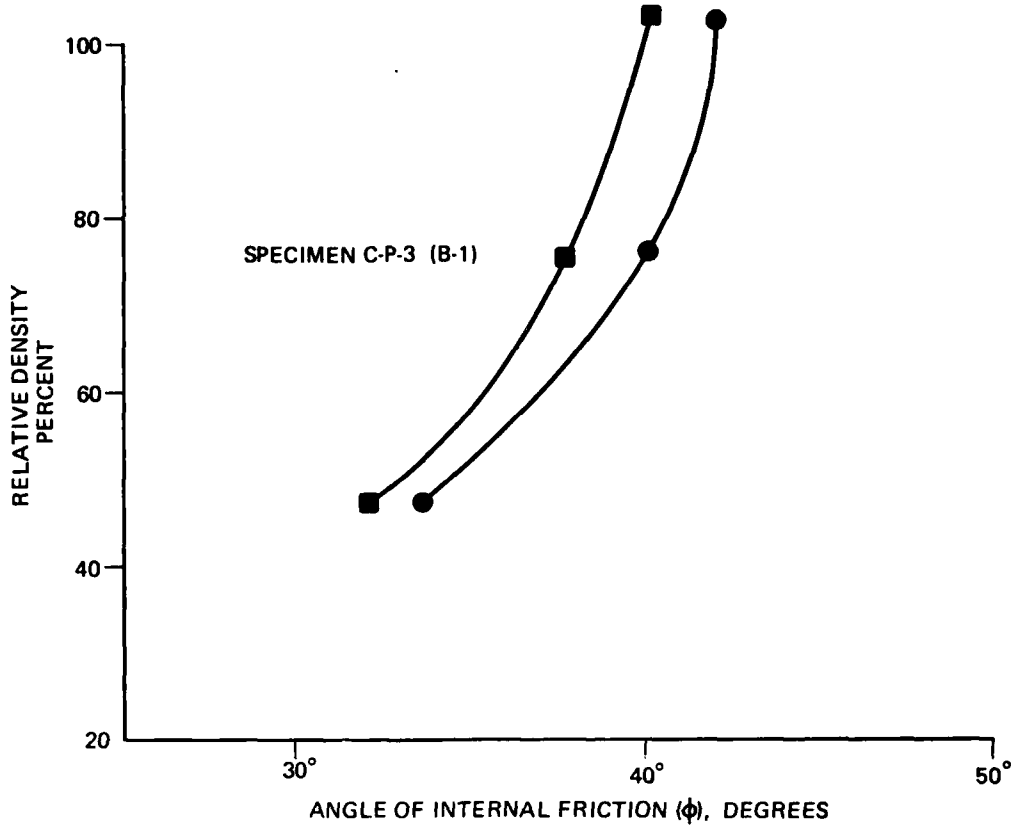
CALIFORNIA BEARING RATIO (CBR) CURVE
UNSOAKED TESTS, TEST TRACK C
ETB MOBILITY STUDY
NEVADA TEST SITE, NEVADA

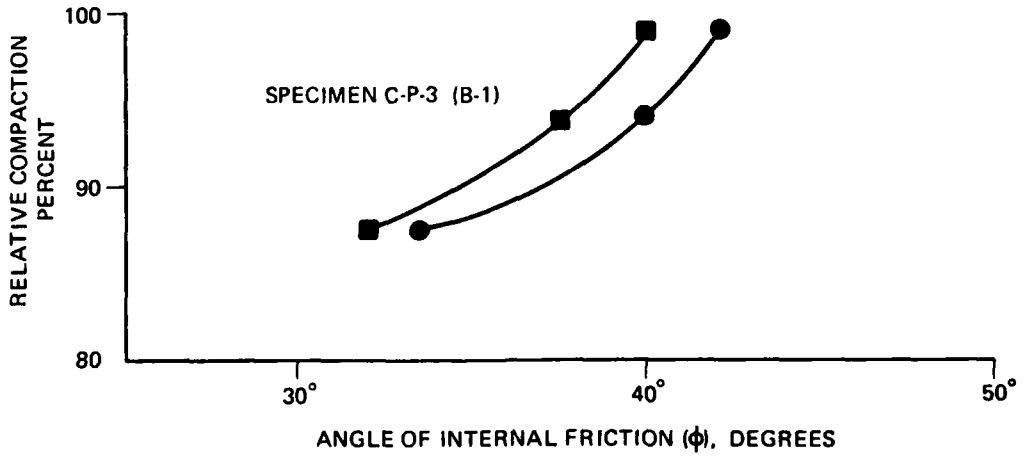
MX SITING INVESTIGATION
DEPARTMENT OF THE AIR FORCE - BMO

FIGURE 4-7

FUGRO NATIONAL, INC.

USAF-07





EXPLANATION

- ■ SPECIMEN WITH OPTIMUM MOISTURE CONTENT
- ● SPECIMEN WITH 5% MOISTURE CONTENT

TRIAXIAL COMPRESSION TEST RESULTS
TEST TRACK C, ETB MOBILITY STUDY
NEVADA TEST SITE, NEVADA

MX SITING INVESTIGATION
DEPARTMENT OF THE AIR FORCE - BMO

FIGURE 4-8

UGRO NATIONAL, INC.

5.0 DISCUSSION OF RESULTS

In this section, the results of both the field and laboratory investigations are discussed briefly.

5.1 TEST TRACK B

The test pits revealed that between grade and the depths of 2.0 to 5.4 feet, the soil is a fine to coarse gravelly sand, red-brown in color, poorly to well-graded, calcareous and contains traces of nonplastic silt, fine gravel, cobbles or boulders. The sieve analysis indicates that the soils are in the SP-SM and SW-SM categories of the Unified Soil Classification System (USCS). All Atterberg limit tests performed classify the soil as nonplastic. This sand is generally dense except at test pits B-P-4 and B-P-8 where it is loose. Stage I and III caliche, with local occurrences of stage IV caliche, exist in this sand sometimes throughout or in the form of layers. This caliche changes the in situ consistency of the sand to a very dense state.

In situ dry densities of uncemented soils at track B ranged from 93.7 to 115.9 pcf. There does not seem to be any obvious trend of increasing density with depth. The limited test results of the in situ moisture contents show that the soils are drier at a greater depth, with 4.7 to 8.0 percent moisture content near the surface decreasing to about two percent at a depth of 3.5 feet. The high moisture content at the surface is due to the rainfall prior to the field work.

Results of the laboratory tests were used to estimate the CBR and angle of internal friction (ϕ) for the soils at track B at their in situ densities (see Table 5-1). The soaked CBR ranged from zero to 46 percent and the unsoaked CBR ranged from zero to 70 percent. The wide range of relative compaction of the in situ soils leads to these extreme values of CBR. The estimated angle of internal friction (ϕ) ranged from 35.3° to 40.5° at optimum moisture content and from 38.5° to 47.5° at field moisture contents.

It is difficult to interpret the CPT results of test track B because of the nonuniform distribution of the caliche cementation. The depth where the CPT met refusal varies from 0.8 to 10.8 feet (see profile in Figure 3-1). Appendix B presents detailed CPT results for track B.

5.2 TEST TRACK C

Between grade and the depth of 3.0 to 5.0 feet, as indicated by the test pits, the soil is a fine to medium sand, brown in color, poorly graded, and calcareous, with traces of nonplastic silt or gravel. The sieve analyses indicate that the soils are in the SP-SM and SW-SM categories of the USCS. The sand is generally medium dense and is underlain by a cemented caliche horizon which could not be excavated by a backhoe.

In situ densities of soils at track C ranged from 97.9 to 112.0 pcf. The limited test results of the in situ moisture contents show that the soils are slightly more moist at depth,

DEPTH INTERVAL (ft)	RANGE OF IN-SITU DRY DENSITY (pcf)	RANGE OF IN-SITU MOISTURE CONTENT (%)	(A) AVERAGE MAXIMUM DRY DENSITY	(B) AVERAGE MAXIMUM AND MINIMUM DRY DENSITY		RANGE OF RELATIVE COMPACTION (%)	RANGE OF RELATIVE DENSITY (%)	(C) RANGE OF ESTIMATED LAB CBR (%)		(D) RANGE OF ESTIMATED ANGLE OF INTERNAL FRICTION ($\phi°$)	
				MAX	MIN			SOAKED	UNSOAKED	OMC	FIELD M/C
1.0-1.5	99.9~115.9	4.7~8.0	123.0	116.7	96.0	81~94	22~97	0~46	0~70	35.5~40.5	38.8~47.5
2.0-2.5	93.7~104.8	3.0~3.2	117.2	116.7	96.0	80~89	47	0~19	0~30	35.3~38.1	38.5~42.5
3.0-3.5	112.1	2.0	—	116.7	96.0	—	81	—	—	—	—
OVERALL RANGE	93.7~115.9	2.0~8.0	117.2~123.0	116.7	96.0	80~94	22~97	0~46	0~70	35.3~40.5	38.5~47.5

NOTES: (A) FROM LABORATORY COMPACTION TESTS.

(B) FROM LABORATORY RELATIVE DENSITY TESTS.

(C) FROM FIGURES 4-2 AND 4-3.

(D) FROM FIGURE 4-4.

OMC–OPTIMUM MOISTURE CONTENT.

FIELD M/C–FIELD MOISTURE CONTENT.

ESTIMATED CBR AND ϕ,
TEST TRACK B, ETB MOBILITY STUDY
NEVADA TEST SITE, NEVADA

MX SITING INVESTIGATION
DEPARTMENT OF THE AIR FORCE - BMO

TABLE 5-1

UGRO NATIONAL, INC.

with 4.9 to 5.8 percent moisture content near the surface increasing to 5.9 to 7.6 percent at a depth of 3.0 to 3.5 feet.

Results of laboartory tests were used to estimate the CBR and angle of internal friction (ϕ) for the soils at track C at their in situ densities (see Table 5-2). The soaked CBR ranged from 12 to 74 percent and the unsoaked CBR ranged from 18 to 64 percent. The estimated angle of internal friction (ϕ) ranged from 31.5° to 41.0° at optium moisture content and from 33.0° to 42.5° at field moisture contents.

A large number of the pre-mobility test q_c (end bearing resistance, tsf) profiles from the CPTs show a steady increase of q_c in the overlying sand to about mid-depth of the total penetration. Then q_c decreases with depth until refusal at the end of the tests when the cone encountered the underlying layer of caliche; see Drawing B-1 in Appendix B. During the week of 4 August 1980, the Terex 33-15 vehicle, equipped with 50/42T tires inflated to 95 psi pressure (wheel load: 65 kips, 30 percent tire deflection, 19" x 42" footprint), traversed the test track at 10 mph for 25 successful passes. On the third day of mobility testing during the 26th pass, the vehicle got stuck near Station 6+00. The tires sank about 10 inches and the undercarriage of the vehicle (7-1/2" clearance above the ground) started dragging. Before getting stuck, the wheels were churning and even applying full throttle (1600 hp engine) did not alleviate the situation. Water was sprayed on the soil where the

DEPTH INTERVAL (ft)	RANGE OF IN SITU DRY DENSITY (pcf)	RANGE OF IN SITU MOISTURE CONTENT (%)	(A) AVERAGE MAXIMUM DRY DENSITY (pcf)	(B) AVERAGE MAXIMUM AND MINIMUM DRY DENSITY (pcf)		RANGE OF RELATIVE COMPACTION (%)	RANGE OF RELATIVE DENSITY (%)	(C) RANGE OF ESTIMATED LAB CBR (%)		(D) RANGE OF ESTIMATED ANGLE OF INTERNAL FRICTION (ϕ°)	
				MAX	MIN			SOAKED	UNSOAKED	OMC	FIELD M/C
1.0-1.5	97.9 ~ 110.2	4.9~5.8	108.7	108.8	90.1	90~101	46~106	12~62	18~57	R.C. 35.0~40.5 R.D. 31.5~40.5	R.C. 36.5~42.5 R.D. 33.0~42.0
2.0-2.5	100.0~108.4	5.7~6.7	108.7	108.8	90.1	92~100	58~98	15~54	26~53	R.C. 36.5~40.5 R.D. 35.0~40.0	R.C. 38.5~42.5 R.D. 36.5~42.0
3.0-3.5	107.8~112.0	5.9~7.6	108.7	108.8	90.1	99~103	96~114	48~76	50~64	R.C. 40.0~41.0 R.D. 39.5	R.C. 42.0~42.5 R.D. 41.5
OVERALL RANGE	97.9 ~ 112.0	4.9~7.6	108.7	108.8	90.1	90~103	46~114	12~76	18~64	31.5 ~ 41.0	33.0 ~ 42.5

NOTES: (A) FROM LABORATORY COMPACTION TESTS.
(B) FROM LABORATORY RELATIVE DENSITY TESTS.
(C) FROM FIGURES 4-6 AND 4-7.
(D) FROM FIGURE 4-8.
OMC – OPTIMUM MOISTURE CONTENT.
FIELD M/C – FIELD MOISTURE CONTENT.
R.C.–FROM RELATIVE COMPACTION VS. ϕ
R.D.–FROM RELATIVE DENSITY VS. ϕ

ESTIMATED CBR AND ϕ
TEST TRACK C, ETB MOBILITY STUDY
NEVADA TEST SITE, NEVADA

MX SITING INVESTIGATION
DEPARTMENT OF THE AIR FORCE - BMO

TABLE 5-2

FUGRO NATIONAL, INC.

tires sank and using a dozer, forklift, and other equipment, the Terex 33-15 was pulled out.

Post-mobility test CPTs were conducted at test track C on 15 and 16 August 1980. Some of these CPTs were performed in the rut formed by the 25 passes of the Terex vehicle. The locations of all pre- and post-mobility test CPTs are shown in Figure 3-2. Appendix B includes results of all initial and post-mobility test CPTs (end-bearing resistance versus depth only). In addition, Table 5-3 presents a numerical comparison of end-bearing resistance before and after mobility testing at depths of 1, 2, and 3 feet.

The post-mobility test CPTs on centerline and 10 feet right of centerline generally indicate an increase in cone resistance at all depths. (At 1-foot depth, q_c increased by 1 to 180 tsf, average being 40 tsf). This increase may be due to a combination of dessication and compaction by the Terex vehicle. The cone resistance decreased somewhat at Stations 6+00 and 7+00, and this decrease was likely caused by disturbance during removal of the stuck Terex vehicle.

The CPTs performed in the left tire tread mark (C-14P through C-25P, and C-38P) indicate an increase in cone resistance between Stations 0+00 to 5+00 and 10+00 to 12+00 and a decrease in cone resistance (at 1 foot depth, range of decrease = 6 to 96 tsf, average = 34 tsf) for the intermediate Stations (6+00 to 9+00). The area of decrease in cone resistance corresponds with the area of visual disturbance by the Terex 33-15 as

CPT NUMBER	CPT LOCATION	DEPTH (ft)	(1) q_c (tsf)	CPT NUMBER (POST MOBILITY TEST)	CPT LOCATION	DEPTH (ft)	(2) q_c (tsf)	(1-2) Δq_c (tsf)	REMARKS
C-1	STA 0+00 ON C.L	1.0	130	C-1P	STA 0+00 ON C.L	1.0	151	+21	C-1P HEAVILY TRAVELED AREA NEAR 3 ROAD INTERSEC.
		2.0	150			2.0	169	+19	
		3.0	115			3.0	155	+40	
C-2	STA 1+00 ON C.L	1.0	85	C-2P	STA 1+00 ON C.L.	1.0	65	-20	C-1P THROUGH C-13P NOT IN TIRE TREAD MARK
		2.0	95			2.0	115	+15	
		3.0	103			3.0	142	+39	
C-3	STA 2+00 ON C.L	1.0	80	C-3P	STA 2+00 ON C.L	1.0	97	+17	C-3P INCREASES POSSIBLY DUE TO DESSICATION
		2.0	110			2.0	145	+35	
		3.0	105			3.0	139	+34	
C-4	STA 3+00 ON C.L	1.0	80	C-4P	STA 3+00 ON C.L	1.0	91	+11	C-4P SURFACE DRY AND DENSE
		2.0	118			2.0	145	+27	
		3.0	175			3.0	162	-13	
C-5	STA 4+00 ON C.L	1.0	83	C-5P	STA 4+00 ON C.L	1.0	70	-13	C-5P SURFACE DRY AND DENSE
		2.0	73			2.0	95	+22	
		3.0	84			3.0	116	+32	
C-6	STA 5+00 ON C.L	1.0	108	C-6P	STA 5+00 ON C.L	1.0	146	+38	C-6P SURFACE DRY AND DENSE
		2.0	100			2.0	130	+30	
		3.0	72			3.0	104	+32	
C-7	STA 6+00 ON C.L	1.0	140	C-7P	STA 6+00 ON C.L	1.0	95	-45	C-7P NEAR AREA WHERE TEREX GOT STUCK, SURFACE DISTURBED
		2.0	200			2.0	80	-120	
		3.0	110			3.0	135	+25	
C-8	STA 7+00 ON C.L	1.0	56	C-8P	STA 7+00 ON C.L	1.0	109	+53	
		2.0	240			2.0	271	+31	
		3.0	215			3.0	222	+7	
C-9	STA 8+00 ON C.L	1.0	76	C-9P	STA 8+00 ON C.L	1.0	113	+37	
		2.0	245			2.0	251	+6	
		3.0	355			3.0	321	-34	
C-10	STA 9+00 ON C.L	1.0	68	C-10P	STA 9+00 ON C.L	1.0	108	+38	
		2.0	245			2.0	257	+12	
		3.0	200			3.0	213	+3	
C-11	STA 10+00 ON C.L.	1.0	100	C-11P	STA 10+00 ON C.L.	1.0	165	+65	
		2.0	114			2.0	161	+27	
		3.0	95			3.0	146	+51	
C-12	STA 11+00 ON C.L	1.0	105	C-12P	STA 11+00 ON C.L	1.0	117	+12	
		2.0	105			2.0	118	+13	
		3.0	101			3.0	87	14	
C-13	STA 12+00 ON C.L	1.0	105	C-13P	STA 12+00 ON C.L.	1.0	138	+33	
		2.0	90			2.0	97	+7	
		3.0	80			3.0	79	-1	
C-14	STA 12+00 10' LT OF C.L.	1.0	76	C-14P	STA 12+00 9' LT OF C.L.	1.0	70	-6	C-14P CENTER OF TIRE TREAD MARK
		2.0	85			2.0	130	+45	
		3.0	[illegible]			3.0	133	+68	
C-15	STA 11+00 10' LT OF C.L.	1.0	105	C-15P	STA 11+00 13' LT OF C.L.	1.0	81	24	C-15P INSIDE EDGE OF TIRE TREAD MARK
		2.0	115			2.0	154	+39	
		3.0	173			3.0	156	17	

CPT NUMBER	LO
C-16	ST. 10' L
C-17	ST 10 L
C-18	ST 10' L
C-19	ST 10' L
C-20	ST 10' L
C-21	ST 10'
C-22	S 10'
C-23	S 10'
C-24	10'
C-25	10'
C-26	10'
C-27	1
C-28	1
C-29	
C-30	

CPT NUMBER	CPT LOCATION	DEPTH (ft.)	(1) q_c (tsf)	CPT NUMBER (POST MOBILITY TEST)	CPT LOCATION	DEPTH (ft.)	(2) q_c (tsf)	(1-2) Δq_c (tsf)	REMARKS
C-16	STA 10+00 10' LT OF C.L.	1.0	92	C-16P	STA 10+00 14.5' LT OF C.L.	1.0	95	+3	C-16P CENTER OF TIRE TREAD MARK
		2.0	95			2.0	135	+40	
		3.0	102			3.0	171	+69	
C-17	STA 9+00 10' LT OF C.L.	1.0	120	C-17P	STA 9+00 17' LT OF C.L.	1.0	95	-25	C-17P OUTSIDE EDGE OF TIRE TREAD MARK
		2.0	195			2.0	122	-73	
		3.0	155			3.0	139	-16	
C-18	STA 8+00 10' LT OF C.L.	1.0	100	C-18P	STA 8+00 13' LT OF C.L.	1.0	53	-47	C-18P INSIDE EDGE OF TIRE TREAD MARK
		2.0	180			2.0	155	-25	
		3.0	170			3.0	215	+45	
C-19	STA 7+00 10' LT OF C.L.	1.0	105	C-19P	STA 7+00 14' LT OF C.L.	1.0	64	-41	C-19P CENTER OF TIRE TREAD MARK
		2.0	175			2.0	164	-11	
		3.0	155			3.0	152	-3	
C-20	STA 6+00 10' LT OF C.L.	1.0	115	C-20P	STA 6+00 16' LT OF C.L.	1.0	19	-96	C-20P OUTSIDE EDGE OF TIRE TREAD MARK
		2.0	165			2.0	65	-100	
		3.0	116			3.0	39	-77	
C-21	STA 5+00 10' LT OF C.L.	1.0	55	C-21P	STA 5+00 12' LT OF C.L.	1.0	56	+1	C-21P INSIDE EDGE OF TIRE TREAD MARK
		2.0	85			2.0	122	+37	
		3.0	80			3.0	146	+66	
C-22	STA 4+00 10' LT OF C.L.	1.0	75	C-22P	STA 4+00 12' LT OF C.L.	1.0	85	+10	C-22P CENTER OF TIRE TREAD MARK
		2.0	92			2.0	157	+65	
		3.0	99			3.0	190	+91	
C-23	STA 3+00 10' LT OF C.L.	1.0	82	C-23P	STA 3+00 14' LT OF C.L.	1.0	110	+28	C-23P OUTSIDE EDGE OF TIRE TREAD MARK
		2.0	113			2.0	200	+87	
		3.0	138			3.0	185	+47	
C-24	STA 2+00 10' LT OF C.L.	1.0	80	C-24P	STA 2+00 13' LT OF C.L.	1.0	90	+10	C-24P INSIDE EDGE OF TIRE TREAD MARK
		2.0	110			2.0	190	+80	
		3.0	123			3.0	195	+72	
C-25	STA 1+00 10' LT OF C.L.	1.0	70	C-25P	STA 1+00 15' LT OF C.L.	1.0	75	+5	C-25P OUTSIDE EDGE OF TIRE TREAD MARK
		2.0	92			2.0	156	+64	
		3.0	71			3.0	0	+99	
C-26	STA 1+00 10' RT OF C.L.	1.0	70	C-26P	STA 1+00 10' RT OF C.L.	1.0	85	+15	C-26P THROUGH C-37P NOT IN TIRE TREAD MARK
		2.0	90			2.0	103	+13	
		3.0	104			3.0	170	+66	
C-27	STA 2+00 10' RT OF C.L.	1.0	75	C-27P	STA 2+00 10' RT OF C.L.	1.0	48	+23	
		2.0	111			2.0	95	-16	
		3.0	95			3.0	109	+14	
C-28	STA 3+00 10' RT OF C.L.	1.0	70	C-28P	STA 3+00 10' RT OF C.L.	1.0	70	±0	
		2.0	105			2.0	142	+37	
		3.0	98			3.0	135	+37	
C-29	STA 4+00 10' RT OF C.L.	1.0	84	C-29P	STA 4+00 10' RT OF C.L.	1.0	109	+25	C-29 NOT IN TIRE TREAD MARK
		2.0	97			2.0	110	+13	
		3.0	83			3.0	96	+13	
C-30	STA 5+00 10' RT OF C.L.	1.0	100	C-30P	STA 5+00 10' RT OF C.L.	1.0	135	+35	
		2.0	118			2.0	119	+1	
		3.0	105			3.0	105	±0	

CPT NUMBER	CPT LOCATION	DEPTH (ft.)	(1) q_c (tsf)
C-31	STA 6+00 10' RT OF C.L.	1.0	100
		2.0	175
		3.0	300
C-32	STA 7+00 10' RT OF C.L.	1.0	120
		2.0	155
		3.0	123
C-33	STA 8+00 10' RT OF C.L.	1.0	110
		2.0	210
		3.0	415
C-34	STA 9+00 10' RT OF C.L.	1.0	102
		2.0	195
		3.0	170
C-35	STA 10+00 10' RT OF C.L.	1.0	98
		2.0	100
		3.0	89
C-36	STA 11+00 10' RT OF C.L.	1.0	101
		2.0	105
		3.0	92
C-37	STA 12+00 10' RT OF C.L.	1.0	67
		2.0	85
		3.0	79
C-38	STA 0+00 10' LT OF C.L.	1.0	83
		2.0	90
		3.0	118
C-39	STA 0+00 10' RT OF C.L.	1.0	170
		2.0	172
		3.0	130
—	—	—	—
		—	—
		—	—
—	—	—	—
		—	—
		—	—
—	—	—	—
		—	—
		—	—

NOTES:

STA	STATION
RT	RIGHT
LT	LEFT
C.L.	CENTER LINE

(1-2) Δq_c (tsf)	REMARKS
+3	C-16P CENTER OF TIRE TREAD MARK
+40	
+69	
-25	C-17P OUTSIDE EDGE OF TIRE TREAD MARK
-73	
-16	
-47	C-18P INSIDE EDGE OF TIRE TREAD MARK
-25	
+45	
-41	C-19P CENTER OF TIRE TREAD MARK
-11	
-3	
-96	C-20P OUTSIDE EDGE OF TIRE TREAD MARK
-100	
-77	
+1	C-21P INSIDE EDGE OF TIRE TREAD MARK
+37	
+66	
+10	C-22P CENTER OF TIRE TREAD MARK
+65	
+91	
+28	C-23P OUTSIDE EDGE OF TIRE TREAD MARK
+87	
+47	
+10	C-24P INSIDE EDGE OF TIRE TREAD MARK
+80	
+72	
+5	C-25P OUTSIDE EDGE OF TIRE TREAD MARK
+64	
+99	
+15	C-26P THROUGH C-37P NOT IN TIRE TREAD MARK
+13	
+66	
+23	
-16	
+14	
±0	
+37	
+37	
+25	C-29 NOT IN TIRE TREAD MARK
+13	
+13	
+35	
+1	
±0	

CPT NUMBER	CPT LOCATION	DEPTH (ft)	(1) q_c (tsf)	CPT NUMBER (POST MOBILITY TEST)	CPT LOCATION	DEPTH (ft)	(1) q_c (tsf)	(1-2) Δq_c (tsf)	REMARKS
C-31	STA 6+00 10' RT OF C.L.	1.0	100	C-31P	STA 6+00 10' RT OF C.L.	1.0	160	+60	
		2.0	175			2.0	175	±0	
		3.0	300			3.0	277	-23	
C-32	STA 7+00 10' RT OF C.L.	1.0	120	C-32P	STA 7+00 10' RT OF C.L.	1.0	200	+80	
		2.0	155			2.0	175	+20	
		3.0	123			3.0	196	+73	
C-33	STA 8+00 10' RT OF C.L.	1.0	110	C-33P	STA 8+00 10' RT OF C.L.	1.0	220	+110	
		2.0	210			2.0	257	+47	
		3.0	415			3.0	422	+7	
C-34	STA 9+00 10' RT OF C.L.	1.0	102	C-34P	STA 9+00 10' RT OF C.L.	1.0	180	+78	
		2.0	195			2.0	236	+41	
		3.0	170			3.0	—	—	
C-35	STA 10+00 10' RT OF C.L.	1.0	98	C-35P	STA 10+00 10' RT OF C.L.	1.0	170	+72	
		2.0	100			2.0	130	+30	
		3.0	89			3.0	95	+6	
C-36	STA 11+00 10' RT OF C.L.	1.0	101	C-36P	STA 11+00 10' RT OF C.L.	1.0	212	+11	
		2.0	105			2.0	155	+50	
		3.0	92			3.0	115	+23	
C-37	STA 12+00 10' RT OF C.L.	1.0	67	C-37P	STA 12+00 10' RT OF C.L.	1.0	40	-27	
		2.0	85			2.0	98	+13	
		3.0	79			3.0	200	+121	
C-38	STA 0+00 10' LT OF C.L.	1.0	83	C-38P	STA 0+00 12' LT OF C.L.	1.0	100	+17	C-38P INSIDE EDGE OF TIRE TREAD MARK
		2.0	90			2.0	150	+60	
		3.0	118			3.0	240	+122	
C-39	STA 0+00 10' RT OF C.L.	1.0	170	C-39P	STA 0+00 10' RT OF C.L.	1.0	250	+180	
		2.0	172			2.0	195	+23	
		3.0	130			3.0	131	+1	
—	—	—	—	C-40P	STA 6+27 4' RT OF C.L.	1.0	9	—	IN HEAVED SOIL AHEAD OF RUT WHERE TEREX STUCK
		—	—			2.0	172	—	
		—	—			3.0	310	—	
—	—	—	—	C-41P	STA 6+23.5 4' RT OF C.L.	1.0	135	—	IN BOTTOM OF RUT WHERE TEREX STUCK
		—	—			2.0	200	—	
		—	—			3.0	245	—	
—	—	—	—	C-42P	STA 6+12 4 RT OF C.L	1.0	129	—	BEHIND DEEP RUT WHERE TEREX STUCK
		—	—			2.0	175	—	
		—	—			3.0	140	—	

NOTES:

STA STATION
RT RIGHT
LT LEFT
C.L. CENTER LINE

COMPARISON OF PRE- AND POST-MOBILITY TEST CPTs
TEST TRACK C
ETB MOBILITY STUDY
NEVADA TEST SITE, NEVADA

MX SITING INVESTIGATION
DEPARTMENT OF THE AIR FORCE BMO

TABLE 5-3

FUGRO NATIONAL, INC.

it sank and became stuck. The decreases tend to be more pronounced at the inner and outer edges of the tire track than at the center.

Three additional CPTs were performed in the right tire tread mark at the location where the Terex bogged down. As expected, the CPT (C-40P) in the heaved soil behind the wheel gave a very low value (8.5 tsf) at shallow depth but increased rapidly thereafter. Visually the upper 1-foot of material was severely displaced and gave the appearance of a pile of loose sand. The CPT (C-41P) at the deepest point of the rut where the Terex got stuck gave fairly high resistance values; this was probably a result of the wetting and compaction induced during removal of the stuck vehicle.

5.3 TEST TRACK G

No test pits were excavated at this test track by Fugro National but the surface material is fine to medium sand, brown in color, poorly graded, and calcareous, with traces of nonplastic silt and gravel. Based on the CPT results, the sand is generally medium dense and is underlain by a caliche layer at a depth of 5 to 6 feet as in track C.

Substantial quantities of water were added during the grading of track G. CPT's were performed following this grading operation. The CPT profiles at track G are very similar to those at track C, therefore, the same comments of Section 5.2. apply with regard to the shape of the q_c versus depth plot. The average

q_c is 63, 93, and 109 tsf at depths of 1, 2, and 3 feet, respectively.

5.4 VIRGIN DESERT

No test pits or field density tests were performed on the virgin desert, but the surface material visually classifies the same as at tracks C and G. The moisture content visually appears to be lower than at tracks C and G.

The seven CPTs performed on the virgin desert, 25 to 35 feet northeast of track G (see CPT logs in Appendix B), have similar q_c profile shapes. Typically, the end bearing resistance (q_c, tsf) steadily increased from the surface to refusal. The depth to refusal ranged from 4.4 to 6.0 feet. End bearing resistance averages 38, 60, and 85 tsf at 1, 2, and 3 feet below grade, respectively.

The CPT profiles of the virgin desert have a distinctly different shape than those of tracks C and G. The test track roadbed materials exhibit a peak cone resistance at 2 to 3 feet, then the resistance drops off before reaching the underlying caliche layer but the CPTs performed on the virgin desert did not exhibit this intermediate peak in cone resistance (see Drawing B-2 in Appendix B). This indicates that the surficial soils in tracks C and G have been compacted to a certain extent by the construction equipment used during the grading operations.

APPENDIX A

Test Pit Logs

A1.0 METHODS OF EXCAVATION OF TEST PITS, SAMPLING, FIELD DENSITY AND MOISTURE CONTENT TESTS

A1.1 Excavation

Test pits were nominally 2 feet wide and ranged from 5 to 10 feet in length. The depths of pits were limited by the hard caliche cementation. The excavated material was deposited on one side at least 4 feet from the edge of the test pits in order to minimize stress loads at the edges. The excavations were backfilled with the excavated material and the ground surface was restored to a condition as conformable with the surrounding terrain as practical.

A1.2 Sampling

The following sampling procedures were generally followed.

- Representative bulk soil samples (large and small) were obtained from different depths.
- All large bulk samples were placed first in plastic bags and then in cloth bags. Small bulk samples were placed in small plastic bags. All sample bags of soil were tied tightly at the top to prevent spillage and tagged with the following information: project number; trench, test pit, or surficial sample number; bulk sample number; depth range in feet; Unified Soil Classification symbol; and date.

A1.3 In Situ Density and M/C

Where possible the in situ field densities and moisture contents were determined at depths of 1.0, 2.0 or 3.0 feet (0.3, 0.6, or 0.9 m). The sand cone method (ASTM 1556-64) was used for the field density determination. The Speedi-Moisture method was used to determine field moisture contents.

A2.0 EXPLANATIONS OF TEST PIT LOGS

Field density and moisture content test results are included in Appendix C, Table C-1.

All data from test pits are presented on standard Fugro National logs. Explanations of the column headings on the logs are as follows:

A. Designations - Test pits are identified as follows:

B-P-1
B - abbreviation for the test track (e.g., test track 'B')
P - abbreviation for test pit
1 - number of test pit

B. Depth - Corresponds to depth below ground surface in meters and feet.

C. Lithology - Graphic representation of the soil and rock types.

D. USCS - Unified Soil Classification System (see Table A-1 for complete details) symbols.

E. Soil Description - Except in cases where samples were classified based on laboratory test data, the descriptions are based on visual classification. The procedures outlined in ASTM D 2487-69, Classification of Soils for Engineering Purposes, and D 2488-69, Description of Soils (Visual-Manual Procedure) were followed. Solid lines across the column indicate known change in strata at the depth shown.

Definitions of some of the terms and criteria to describe soils and conditions encountered during the exploration follow.

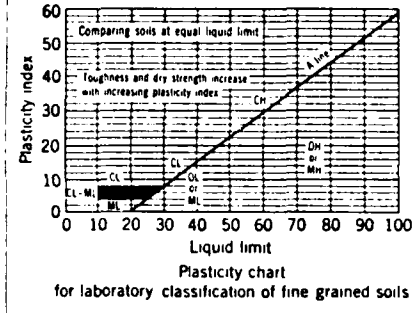
Gradation : A coarse-grained soil is well graded if it has a wide range in grain size and substantial amounts of most intermediate particle sizes.

Poorly graded indicates that the soil consists predominantly of one size (uniformly graded) or has a wide range of sizes with some intermediate sizes obviously missing (gap-graded).

UNIFIED SOIL CLASSIFICATION SYSTEM

Field Identification Procedures (Excluding particles larger than 3 in. and basing fractions on estimated weights)				Group Symbols [a]	Typical Names	Information Required for Describing Soils	Laboratory Classification Criteria
Coarse-grained soils: More than half of material is larger than No. 200 sieve size [b]	Gravels: More than half of coarse fraction is larger than No. 4 sieve size	Clean gravels (little or no fines)	Wide range in grain size and substantial amounts of all intermediate particle sizes	GW	Well graded gravels, gravel-sand mixtures, little or no fines	Give typical name; indicate approximate percentages of sand and gravel, maximum size; angularity, surface condition, and hardness of the coarse grains; local or geologic name and other pertinent descriptive information, and symbols in parentheses For undisturbed soils add information on stratification, degree of compactness, cementation, moisture conditions and drainage characteristics Example: *Silty sand*, gravelly; about 20%, hard, angular gravel particles ½-in. maximum size, rounded and subangular sand grains coarse to fine, about 15% non-plastic fines with low dry strength; well compacted and moist in place; alluvial sand; (*SM*)	$C_U = \frac{D_{60}}{D_{10}}$ Greater than 4 $C_C = \frac{(D_{30})^2}{D_{10} \times D_{60}}$ Between 1 and 3 Not meeting all gradation requirements for *GW* Atterberg limits below "A" line, or *PI* less than 4 / Above "A" line with *PI* between 4 and 7 are *borderline* cases requiring use of dual symbols Atterberg limits above "A" line, with *PI* greater than 7
			Predominantly one size or a range of sizes with some intermediate sizes missing	GP	Poorly graded gravels, gravel-sand mixtures, little or no fines		
		Gravels with fines (appreciable amount of fines)	Nonplastic fines (for identification procedures see *ML* below)	GM	Silty gravels, poorly graded gravel-sand-silt mixtures		
			Plastic fines (for identification procedures, see *CL* below)	GC	Clayey gravels, poorly graded gravel-sand-clay mixtures		
	Sands: More than half of coarse fraction is smaller than No. 4 sieve size (For visual classification, the ¼ in. size may be used as equivalent to the No. 4 sieve size)	Clean sands (little or no fines)	Wide range in grain sizes and substantial amounts of all intermediate particle sizes	SW	Well graded sands, gravelly sands, little or no fines		$C_U = \frac{D_{60}}{D_{10}}$ Greater than 6 $C_C = \frac{(D_{30})^2}{D_{10} \times D_{60}}$ Between 1 and 3 Not meeting all gradation requirements for *SW* Atterberg limits below "A" line or *PI* less than 5 / Above "A" line with *PI* between 4 and 7 are *borderline* cases requiring use of dual symbols Atterberg limits below "A" line with *PI* greater than 7
			Predominantly one size or a range of sizes with some intermediate sizes missing	SP	Poorly graded sands, gravelly sands, little or no fines		
		Sands with fines (appreciable amount of fines)	Nonplastic fines (for identification procedures, see *ML* below)	SM	Silty sands, poorly graded sand-silt mixtures		
			Plastic fines (for identification procedures, see *CL* below)	SC	Clayey sands, poorly graded sand-clay mixtures		
Identification Procedures on Fraction Smaller than No. 40 Sieve Size							
Fine-grained soils: More than half of material is *smaller* than No. 200 sieve size (The No. 200 sieve size is about the smallest particle visible to naked eye)		Dry Strength (crushing characteristics)	Dilatancy (reaction to shaking)	Toughness (consistency near plastic limit)			
	Silts and clays: liquid limit less than 50	None to slight	Quick to slow	None	ML	Inorganic silts and very fine sands, rock flour, silty or clayey fine sands with slight plasticity	Determine percentages of gravel and sand from grain size curve Depending on percentage of fines (fraction smaller than No. 200 sieve size) coarse grained soils are classified as follows: Less than 5% — *GW, GP, SW, SP* More than 12% — *GM, GC, SM, SC* 5% to 12% — Borderline cases requiring use of dual symbols
		Medium to high	None to very slow	Medium	CL	Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays	
		Slight to medium	Slow	Slight	OL	Organic silts and organic silt-clays of low plasticity	
	Silts and clays: liquid limit greater than 50	Slight to medium	Slow to none	Slight to medium	MH	Inorganic silts, micaceous or diatomaceous fine sandy or silty soils, elastic silts	
		High to very high	None	High	CH	Inorganic clays of high plasticity, fat clays	
		Medium to high	None to very slow	Slight to medium	OH	Organic clays of medium to high plasticity	
Highly Organic Soils		Readily identified by colour, odour, spongy feel and frequently by fibrous texture			Pt	Peat and other highly organic soils	

Use grain size curve in identifying the fractions as given under field identification



Plasticity chart
for laboratory classification of fine grained soils

From Wagner, 1957.

[a] *Boundary classifications*. Soils possessing characteristics of two groups are designated by combinations of group symbols. For example *GW-GC*, well graded gravel-sand mixture with clay binder.

[b] All sieve sizes on this chart are U.S. standard.

Field Identification Procedure for Fine Grained Soils or Fractions

These procedures are to be performed on the minus No. 40 sieve size particles, approximately ½₆ in. For field classification purposes, screening is not intended, simply remove by hand the coarse particles that interfere with the tests.

Dilatancy (Reaction to shaking)

After removing particles larger than No. 40 sieve size, prepare a pat of moist soil with a volume of about one-half cubic inch. Add enough water if necessary to make the soil soft but not sticky.

Place the pat in the open palm of one hand and shake horizontally, striking vigorously against the other hand several times. A positive reaction consists of the appearance of water on the surface of the pat which changes to a livery consistency and becomes glossy. When the sample is squeezed between the fingers the water and gloss disappear from the surface, the pat stiffens and finally it cracks or crumbles. The rapidity of appearance of water during shaking and of its disappearance during squeezing assist in identifying the character of the fines in a soil.

Very fine clean sands give the quickest and most distinct reaction whereas a plastic clay has no reaction. Inorganic silts, such as a typical rock flour, show a moderately quick reaction.

Dry Strength (Crushing characteristics)

After removing particles larger than No. 40 sieve size, mould a pat of soil to the consistency of putty, adding water if necessary. Allow the pat to dry completely by oven, sun or air drying, and then test its strength by breaking and crumbling between the fingers. This strength is a measure of the character and quantity of the colloidal fraction contained in the soil. The dry strength increases with increasing plasticity.

High dry strength is characteristic for clays of the CH group. A typical inorganic silt possesses only very slight dry strength. Silty fine sands and silts have about the same slight dry strength, but can be distinguished by the feel when powdering the dried specimen. Fine sand feels gritty whereas a typical silt has the smooth feel of flour.

Toughness (Consistency near plastic limit)

After removing particles larger than the No. 40 sieve size, a specimen of soil about one-half inch cube in size, is moulded to the consistency of putty. If too dry, water must be added and if sticky, the specimen should be spread out in a thin layer and allowed to lose some moisture by evaporation. Then the specimen is rolled out by hand on a smooth surface or between the palms into a thread about one-eight inch in diameter. The thread is then folded and re-rolled repeatedly. During this manipulation the moisture content is gradually reduced and the specimen stiffens, finally loses its plasticity, and crumbles when the plastic limit is reached.

After the thread crumbles, the pieces should be lumped together and a slight kneading action continued until the lump crumbles.

The tougher the thread near the plastic limit and the stiffer the lump when it finally crumbles, the more potent is the colloidal clay fraction in the soil. Weakness of the thread at the plastic limit and quick loss of coherence of the lump below the plastic limit indicate either inorganic clay of low plasticity, or materials such as kaolin-type clays and organic clays which occur below the A-line.

Highly organic clays have a very weak and spongy feel at the plastic limit.

MX SITING INVESTIGATION
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TABLE A-1

WOODWARD-CLYDE CONSULTANTS

Moisture :

Dry	- no feel of moisture
Slightly Moist	- much less than normal moisture
Moist	- normal moisture for soil
Very Moist	- much greater than normal moisture
Wet	- for soils below the water table

Consistency: Consistency descriptions of coarse-grained soils (GW, GP, GM, GC, SW, SP, SM, SC) are as follows.

Consistency

Very Loose
Loose
Medium Dense
Dense
Very Dense

Grain Shape:

Angular - particles have sharp edges and relatively plane sides with unpolished surfaces.

Subangular - particles are similar to angular but have somewhat rounded edges.

Subrounded - particles exhibit nearly plane sides but have well-rounded corners and edges.

Rounded - particles have smoothly curved sides and no edges.

Calcareous : Containing calcium carbonate; presence of calcium carbonate is commonly identified on the basis of reaction with dilute hydrochloric acid.

Caliche : Soils cemented by calcium carbonate and/or other soluble minerals by upward-moving solutions.

Degree of Cementation: (Stages of development of caliche profile)

Stage	Gravelly Soils	Nongravelly Soils
I	Thin, discontinuous pebble coatings	Few filaments or faint coatings

II	Continuous pebble coatings, some interpebble fillings	Few to abundant nodules, flakes, filaments
III	Many interpebble fillings	Many nodules and internodular fillings
IV	Laminar horizon overlying plugged horizon	Increasing carbonate impregnation

Secondary Material : Example - Sand with trace to some silt

Trace - 5-12% (by dry weight)
Little - 13-20% (by dry weight)
Some - >20% (by dry weight)

Plasticity : Plasticity index is the range of water content, expressed as a percentage of the weight of the oven-dried soil, through which the soil is plastic. It is defined as the liquid limit minus the plastic limit. Descriptive ranges used on the logs include:

Nonplastic (PI, 0 - 4)
Slightly Plastic (PI, 4 - 15)
Medium Plastic (PI, 15 - 30)
Highly Plastic (PI, >30)

Cobbles and Boulders : A cobble is a rock fragment, usually rounded by weathering or abrasion, with an average diameter ranging between 3 and 12 inches.

A boulder is a rock fragment, usually rounded by weathering or abrasion, with an average diameter of 12 inches or more.

I. Remarks - This column was provided on test pit logs for comments regarding number and size of cobbles or boulders encountered, trench wall stability, and other conditions encountered during excavations.

K. Sieve Analysis - The numbers represent the percentage by dry weight (ASTM D 422-63) of each of the following soil components:

GR - Gravel, rock particles that will pass a 3-inch sieve and are retained on No. 4 sieve.

SA - Sand, soil particles passing No. 4 sieve and retained on No. 200 sieve.

FI - Fines, silt or clay, soil particles passing No. 200 sieve.

L. Atterberg Limits (LL and PI) -

LL - Liquid Limit, the water content corresponding to the arbitrary limit between the liquid and plastic states of consistency of a soil (ASTM D 423-66).

PL - Plastic Limit, the water content corresponding to an arbitrary limit between the plastic and the semisolid state of consistency of a soil (ASTM D 424-59).

PI - Plasticity Index, numerical difference between the liquid limit (LL) and the plastic limit (PL) indicating the range of moisture content within which a soil-water mixture is plastic.

NP - Nonplastic.

BULK SAMPLE	DEPTH METERS	DEPTH FEET	LITHOLOGY	USCS	CONSISTENCY	SOIL DESCRIPTION	REMARKS	SIEVE ANALYSIS GR	SA	FI	LL	PI
	0	0				GRAVELLY SAND, red-brown, fine to coarse, well graded, slightly moist, subangular, calcareous; little fine gravel; trace nonplastic silt; trace cobbles and boulders to 14" size; stage I caliche (0.0-2.0); stage IV caliche (2.0'-2.5').		19	69	12		NP
		1		SP-SM	dense							
		2			very dense							
						TOTAL DEPTH 2.5' (0.8 m)						
	1	3										
		4										
		5										

SURFACE ELEVATION:
SURFICIAL GEOLOGIC UNIT:

LOG OF TEST PIT B-P-1

BULK SAMPLE	DEPTH METERS	DEPTH FEET	LITHOLOGY	USCS	CONSISTENCY	SOIL DESCRIPTION	REMARKS	SIEVE ANALYSIS GR	SA	FI	LL	PI
	0	0				GRAVELLY SAND, light brown to white, fine to coarse, poorly graded, slightly moist, angular to subangular, calcareous; some fine gravel; trace nonplastic silt; trace to little cobbles and boulders to 13" size; stage III-IV caliche.		26	67	7		NP
		1		SP-SM	very dense							
		2				TOTAL DEPTH 2.0 (0.6 m)						
	1	3										
		4										
		5										

SURFACE ELEVATION:
SURFICIAL GEOLOGIC UNIT:

LOG OF TEST PIT B-P-2

LOGS OF TEST PITS B-P-1 AND B-P-2, TEST TRACK B
ETB MOBILITY STUDY
NEVADA TEST SITE, NEVADA

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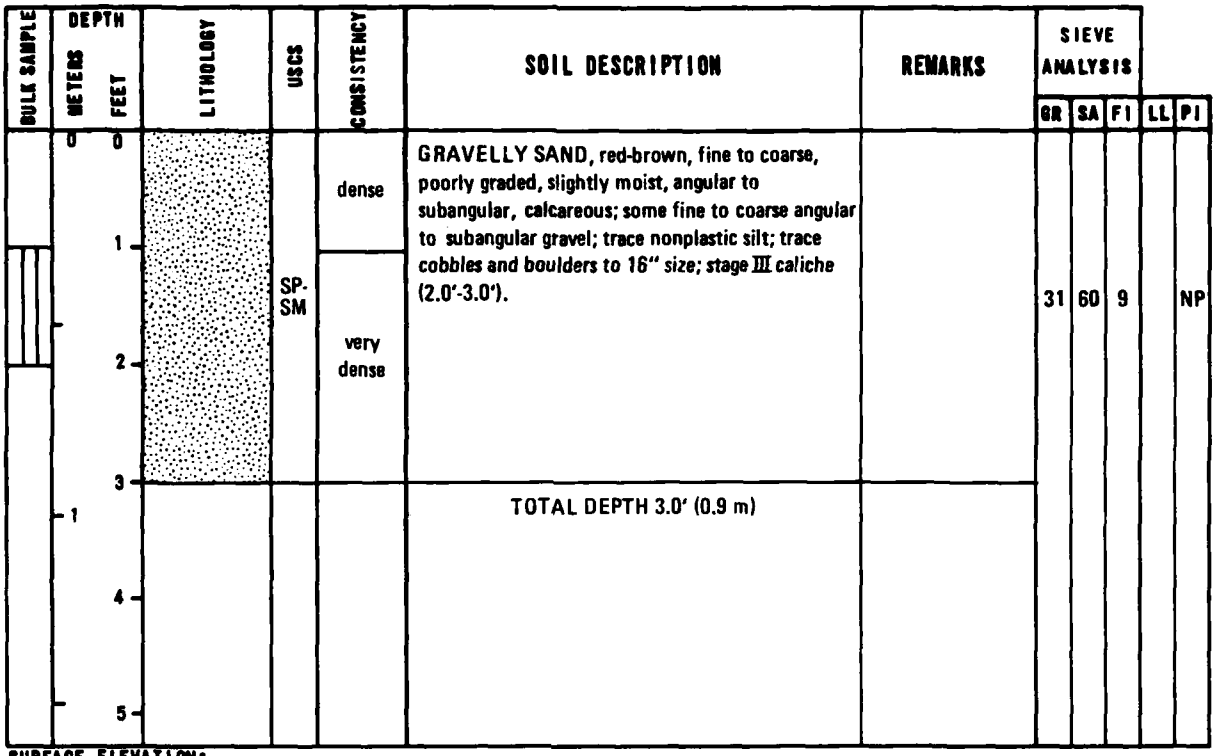
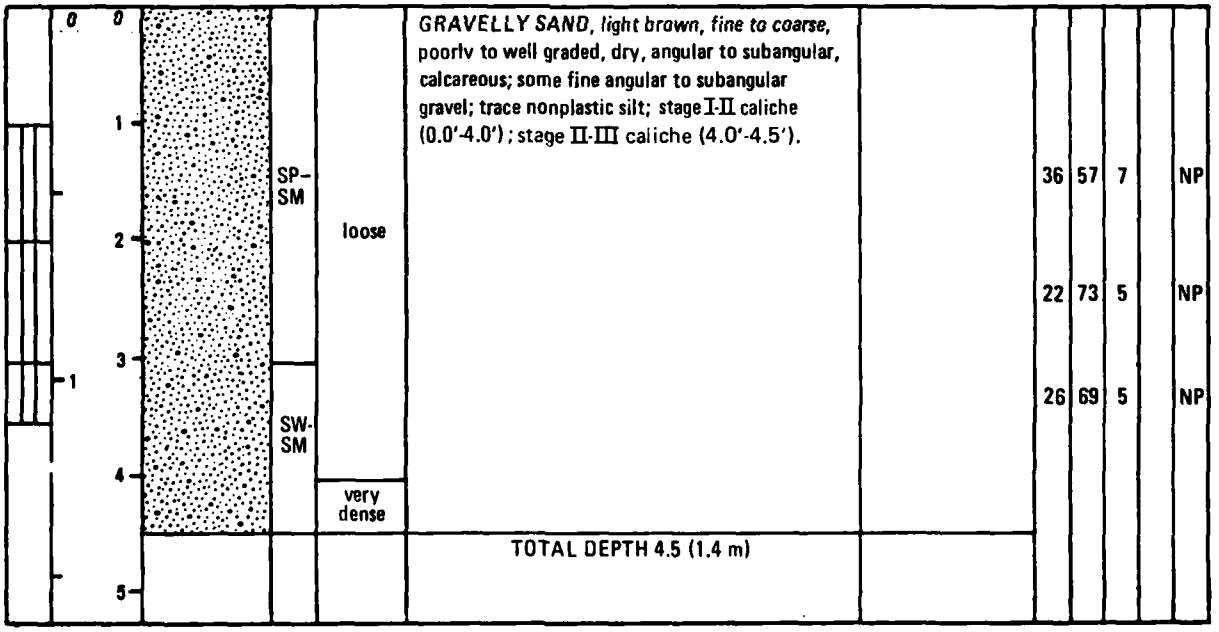
FIGURE A-1

FUGRO NATIONAL, INC.

USAF-38





LOGS OF TEST PITS B-P-3 AND B-P-4, TEST TRACK B
ETB MOBILITY STUDY
NEVADA TEST SITE, NEVADA

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FIGURE
A-2

FUGRO NATIONAL, INC.

USAF-38

BULK SAMPLE	DEPTH METERS	DEPTH FEET	LITHOLOGY	USCS	CONSISTENCY	SOIL DESCRIPTION	REMARKS	SIEVE ANALYSIS GR	SA	FI	LL	PI
	0	0		SP-SM	dense	GRAVELLY SAND, red-brown to white-brown, fine to coarse, poorly graded, slightly moist, angular to subangular, calcareous; some fine angular to subangular gravel; trace nonplastic silt; occasional cobbles to 5" size; stage II caliche (0.0'-3.5'); stage II-III caliche (3.5'-4.0').		23	65	12		NP
		1										
		2										
	1	3										
		4			very dense							
		5				TOTAL DEPTH 4.0' (1.2 m)						

SURFACE ELEVATION:
SURFICIAL GEOLOGIC UNIT:

LOG OF TEST PIT B-P-5

BULK SAMPLE	DEPTH METERS	DEPTH FEET	LITHOLOGY	USCS	CONSISTENCY	SOIL DESCRIPTION	REMARKS	SIEVE ANALYSIS GR	SA	FI	LL	PI
	0	0		SP SM	dense	GRAVELLY SAND, light brown-white, fine to coarse poorly graded, dry, angular, calcareous; little fine gravel; trace nonplastic silt; stage II-III caliche throughout.		20	71	9		NP
		1			very dense		cementation					
		2										
	1	3			dense							
		4										
		5				TOTAL DEPTH 5.0' (1.5 m)						

SURFACE ELEVATION:
SURFICIAL GEOLOGIC UNIT:

LOG OF TEST PIT B-P-6

LOGS OF TEST PITS B-P-5 AND B-P-6, TEST TRACK B
ETB MOBILITY STUDY
NEVADA TEST SITE, NEVADA.

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FIGURE A-3

UGRO NATIONAL, INC.

USAF-38

BULK SAMPLE	DEPTH METERS	DEPTH FEET	LITHOLOGY	USCS	CONSISTENCY	SOIL DESCRIPTION	REMARKS	SIEVE ANALYSIS GR	SA	FI	LL	PI
	0	0										
		1		SP-SM	dense	SAND, red-brown, fine to coarse, poorly graded, slightly moist, subangular, calcareous; trace fine angular to subangular gravel; trace nonplastic silt; stage IV caliche (2.0'-2.2').		11	79	10		NP
		2										
						TOTAL DEPTH 2.2 ' (0.7 m)						
	1	3										
		4										
		5										

SURFACE ELEVATION:
SURFICIAL GEOLOGIC UNIT:

LOG OF TEST PIT B-P-7

	0	0										
		1										
		2										
	1	3										
		4										
		5										

SURFACE ELEVATION:
SURFICIAL GEOLOGIC UNIT:

LOG OF TEST PIT

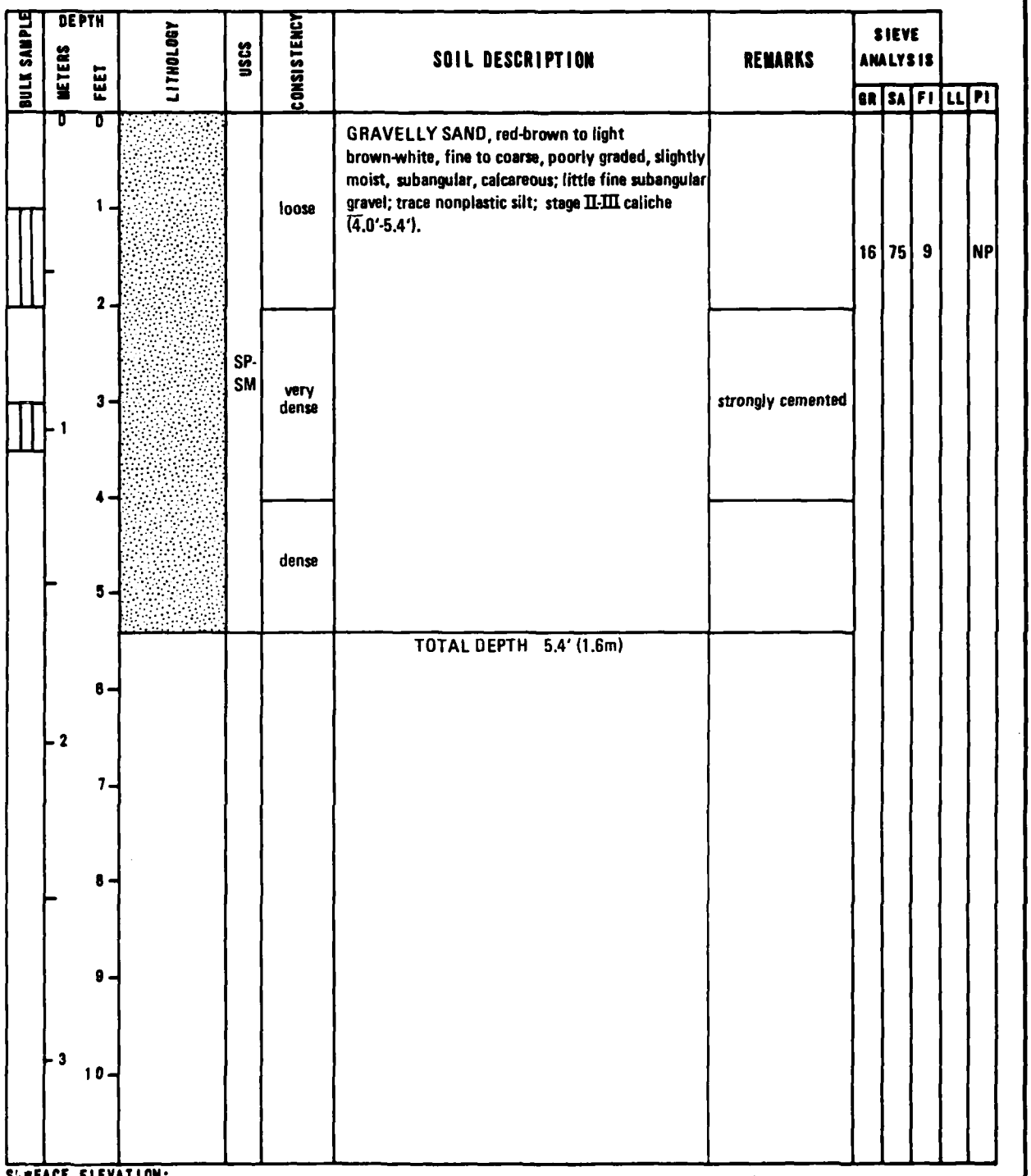
LOG OF TEST PIT B-P-7, TEST TRACK B
ETB MOBILITY STUDY
NEVADA TEST SITE, NEVADA

MX SITING INVESTIGATION
DEPARTMENT OF THE AIR FORCE - BMO

FIGURE A-4

FUGRO NATIONAL, INC.

USAF-36



SURFACE ELEVATION:
SURFICIAL GEOLOGIC UNIT:

LOG OF TEST PIT B-P-8

LOG OF TEST PIT B-P-8, TEST TRACK B
ETB MOBILITY STUDY
NEVADA TEST SITE, NEVADA

MX SITING INVESTIGATION
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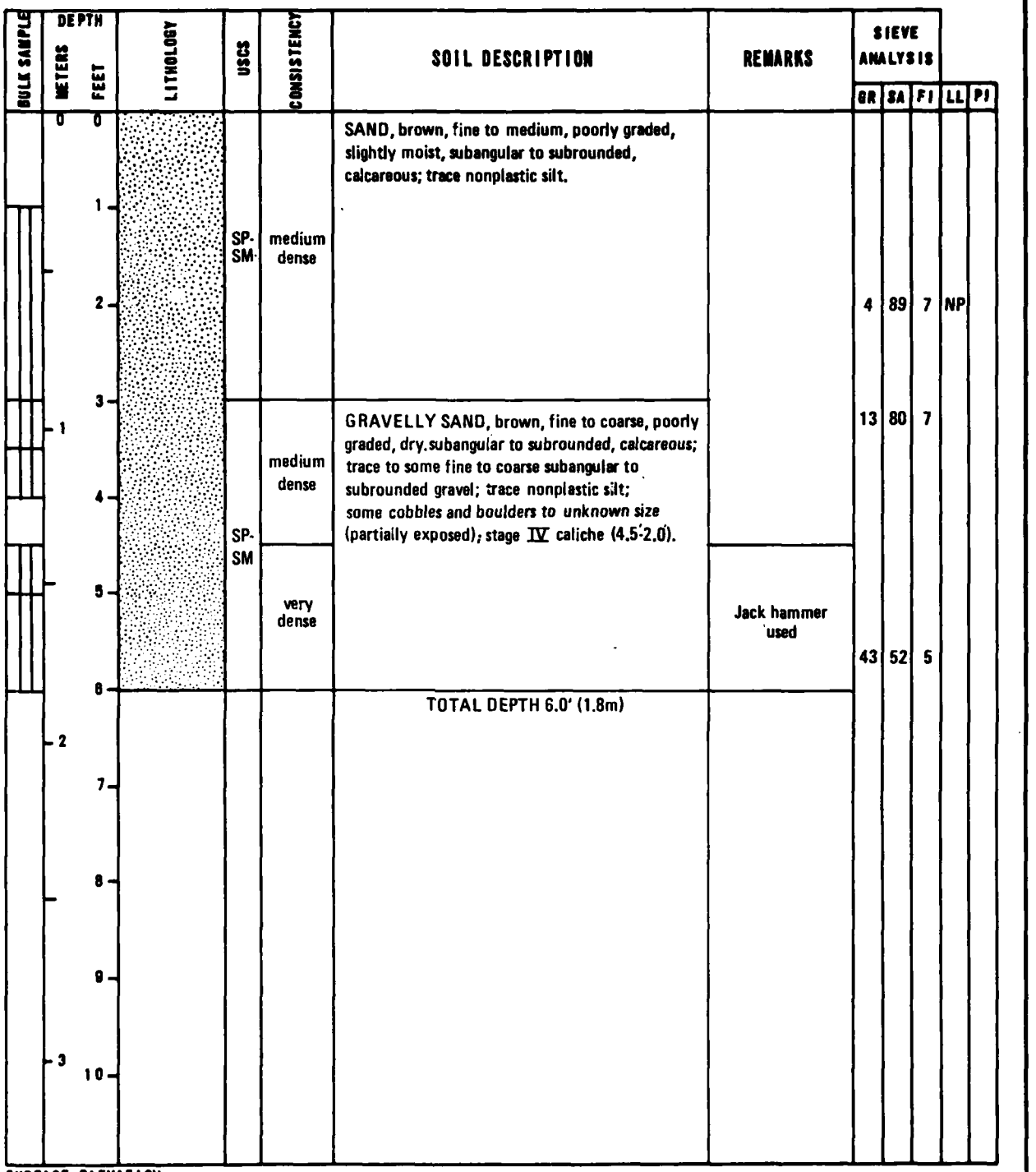
FIGURE
A-5

FUGRO NATIONAL, INC.

USAF-21



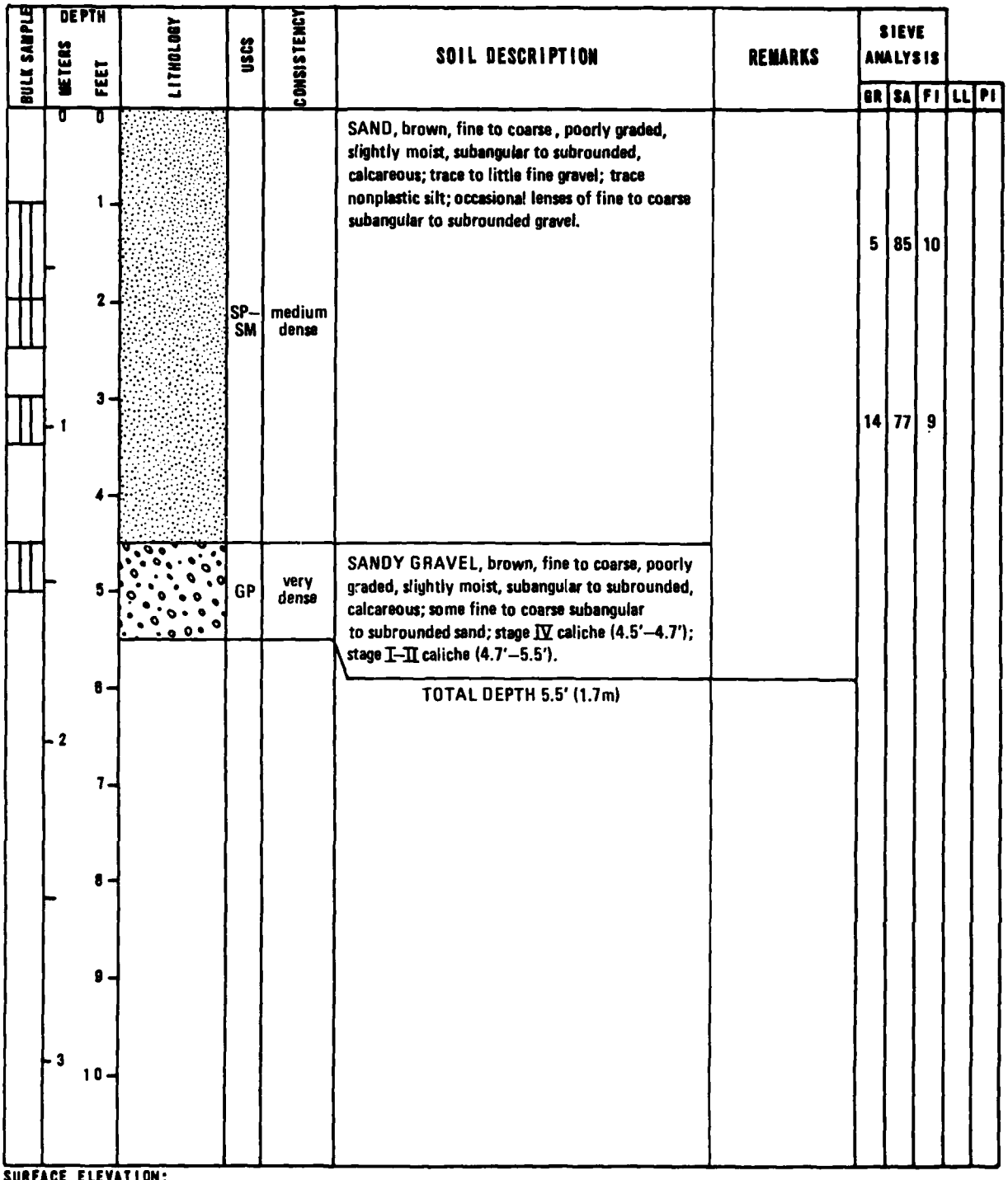
LOG OF TEST PIT C-P-1, TEST TRACK C
ETB MOBILITY STUDY
NEVADA TEST SITE, NEVADA

MX SITING INVESTIGATION
DEPARTMENT OF THE AIR FORCE - BMO

FIGURE
A-6

FUGRO NATIONAL, INC.

USAF-21



LOG OF TEST PIT C-P-2

LOG OF TEST PIT C-P-2, TEST TRACK C
ETB MOBILITY STUDY
NEVADA TEST SITE, NEVADA

MX SITING INVESTIGATION
DEPARTMENT OF THE AIR FORCE - BMO

FIGURE
A-7

FUGRO NATIONAL, INC.

USAF-21

BULK SAMPLE	DEPTH METERS	DEPTH FEET	LITHOLOGY	USCS	CONSISTENCY	SOIL DESCRIPTION	REMARKS	SIEVE ANALYSIS GR	SA	FI	LL	PI
	0	0				SAND, brown, fine to medium, poorly graded, slightly moist to dry, subangular to subrounded, calcareous; trace nonplastic silt; trace fine gravel; stage IV caliche at 5.0'.						
		1			medium dense			5	87	8		
		2		SP-SM				4	87	9		
	1	3			dense							
		4						2	88	10		
		5				TOTAL DEPTH 5.0' (1.5m).						

SURFACE ELEVATION:
SURFICIAL GEOLOGIC UNIT:

LOG OF TEST PIT C-P-3

BULK SAMPLE	DEPTH METERS	DEPTH FEET	LITHOLOGY	USCS	CONSISTENCY	SOIL DESCRIPTION	REMARKS	SIEVE ANALYSIS GR	SA	FI	LL	PI
	0	0				SAND, brown, fine to coarse, poorly graded, slightly moist, subangular to subrounded, calcareous; trace nonplastic silt; trace fine gravel.						
		1		SP-SM	dense			6	83	11		
		2						9	81	10		
	1	3		SW-SM	dense	GRAVELLY SAND, brown, fine to coarse, well graded, slightly moist, subangular to subrounded, calcareous; little fine gravel; trace nonplastic silt.		20	74	6		
		4				TOTAL DEPTH 3.5' (1.1m)						
		5										

SURFACE ELEVATION:
SURFICIAL GEOLOGIC UNIT:

LOG OF TEST PIT C-P-4

LOG OF TEST PIT C-P-3 AND C-P-4, TEST TRACK C
ETB MOBILITY STUDY
NEVADA TEST SITE, NEVADA

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FIGURE A-8

UGRO NATIONAL, INC.

USAF-30

APPENDIX B

Results of Cone Penetration Tests

B1.0 CONE PENETRATION TEST METHOD

B1.1 Equipment

The equipment consisted of a truck-mounted [17.5 tons gross weight] electronic cone penetrometer equipped with a 15-ton friction cone (cone end resistance capacity of 15 tons and 4-1/2-ton limit on the friction sleeve). All operating controls, recorder, cables, and ancillary equipment were housed in the specially designed vehicle which was completely self-contained. The penetrometer, the key element of the system, contained the necessary load cells and cable connections. One end of the unit was threaded to receive the first sounding rod. When carrying out the tests, hollow rods with an outside diameter of 1.42 inches and a length of 3.3 feet were used to push down the cone.

The hydraulic thrust system was mounted over the center of gravity of the truck, permitting use of the full 17.5-ton truck weight as load reaction.

The cone had an apex angle of 60° and a base area of 2.3 in^2. The resistance to penetration was measured by a built-in load cell in the tip and was relayed to the surface recorder via cables in the sounding rods. The friction sleeve, having an area of 31.4 in^2, was fitted above the cone base. The local friction was measured by load cells mounted in the friction sleeve and recorded in the same manner as the end resistance. The end resistance and friction resistance were recorded on a strip chart.

B1.2 Test Method

Tests were performed in accordance with ASTM D3441-75T, "Tentative Method for Deep, Quasi-Static, Cone and Friction-Cone Penetration Tests of Soil." Basically, the test was conducted by positioning the electronic cone penetrometer truck over the designated area for testing, setting the outriggers on the ground surface, checking the level of the rig, then pushing the cone into the ground at a rate of 0.79 in/s until refusal (defined as the capacity of the cone, friction sleeve, or hydraulics system) or the desired depth of penetration was reached.

B2.0 CPT RESULTS

The results of all cone penetration tests are presented in Drawings B-1, and B-2. Explanations of the test results are as follows:

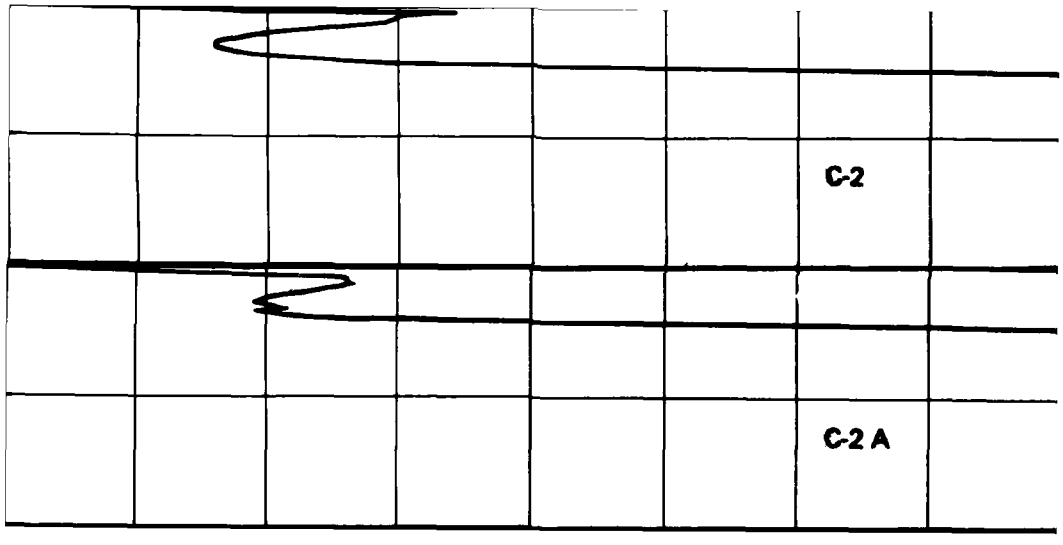
A. Depth - Corresponds to depth below ground surface.

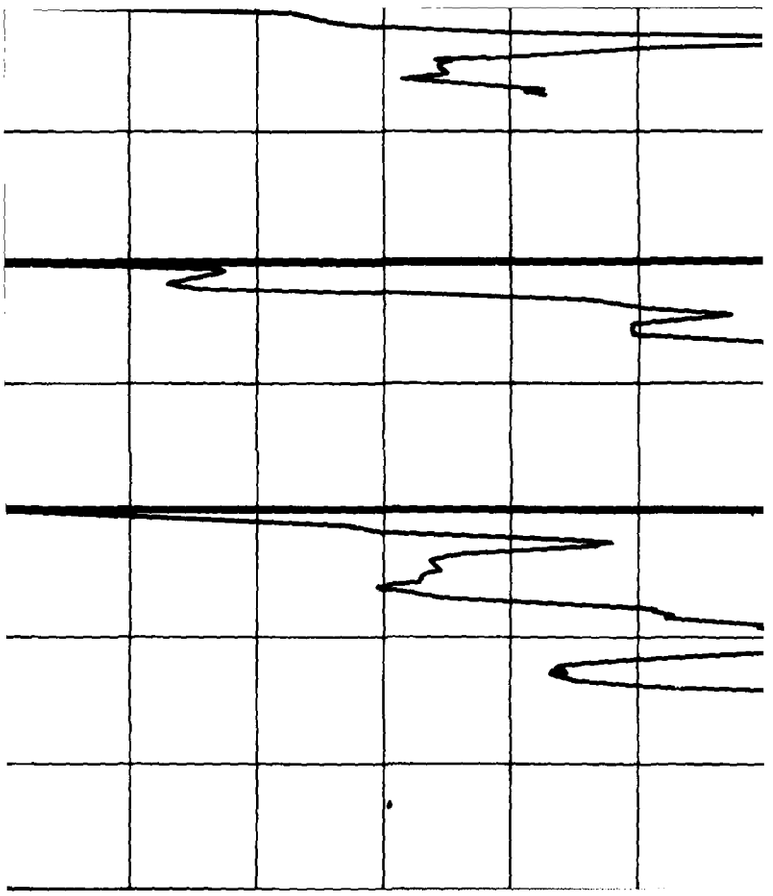
B. Cone Resistance - The resistance to penetration developed by the cone, equal to the vertical force applied to the cone divided by its horizontally projected area.

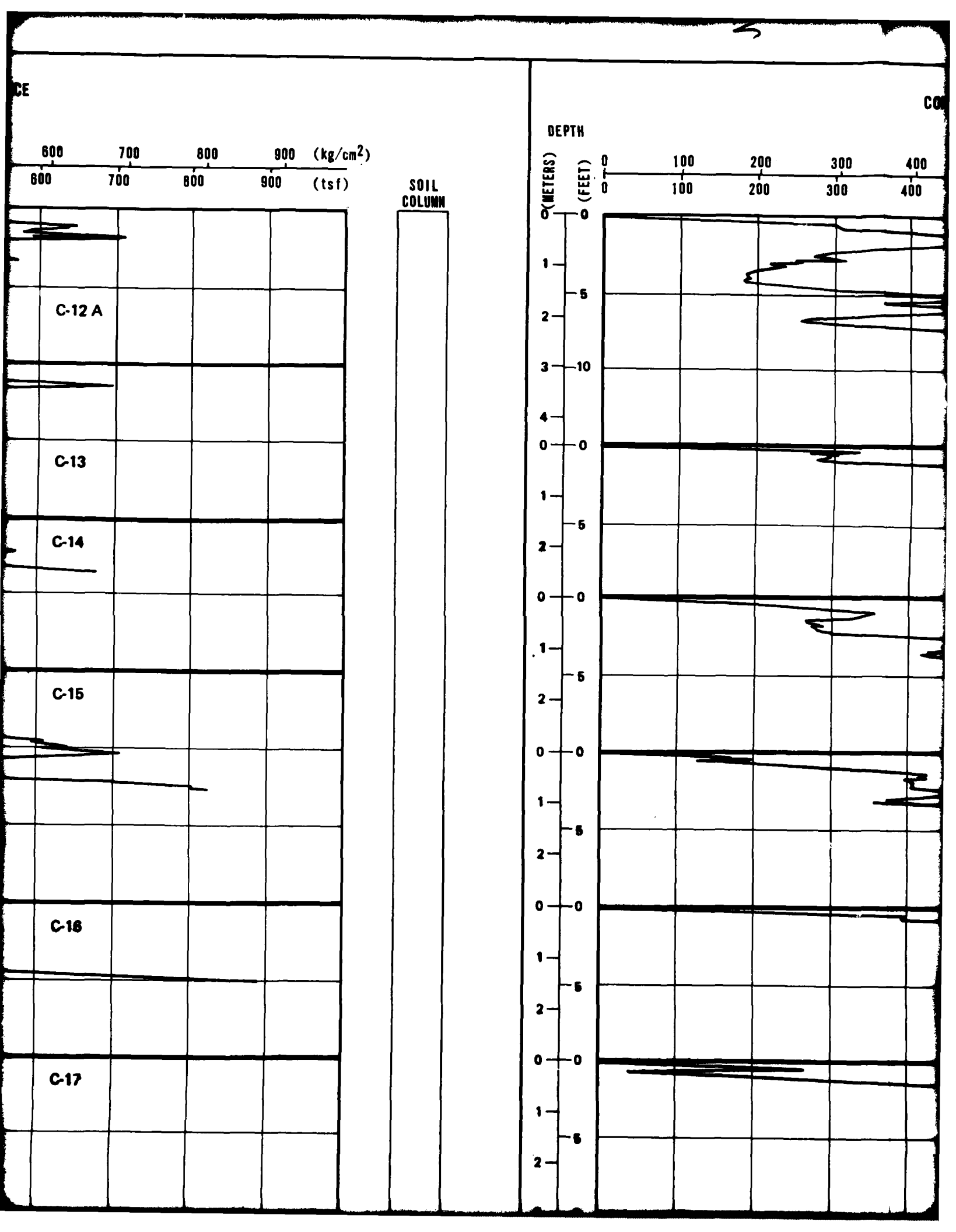
C. Designation - Each cone penetrometer test is identified by a number: for example C-1.

C - abbreviation for the CPT
1 - number of the test

D. Soil Column - A graphical presentation of the soil type versus depth at those cone penetrometer test locations where the corresponding test pits are five (5) to ten (10) feet away. The Unified Soil Classification Symbol for each different soil type is listed immediately to the left of the soil column. Immediately below the soil column,where applicable the number for the corresponding test pit at each CPT location is given.


C-2
C-2 A




CE
CO
600
700
800
900
(kg/cm²)
600
700
800
900
(tsf)
SOIL COLUMN
C-12 A
C-13
C-14
C-15
C-16
C-17
DEPTH
(METERS)
(FEET)
0
100
200
300
400
0
100
200
300
400
0
1
2
3
4
0
1
2
0
1
2
0
1
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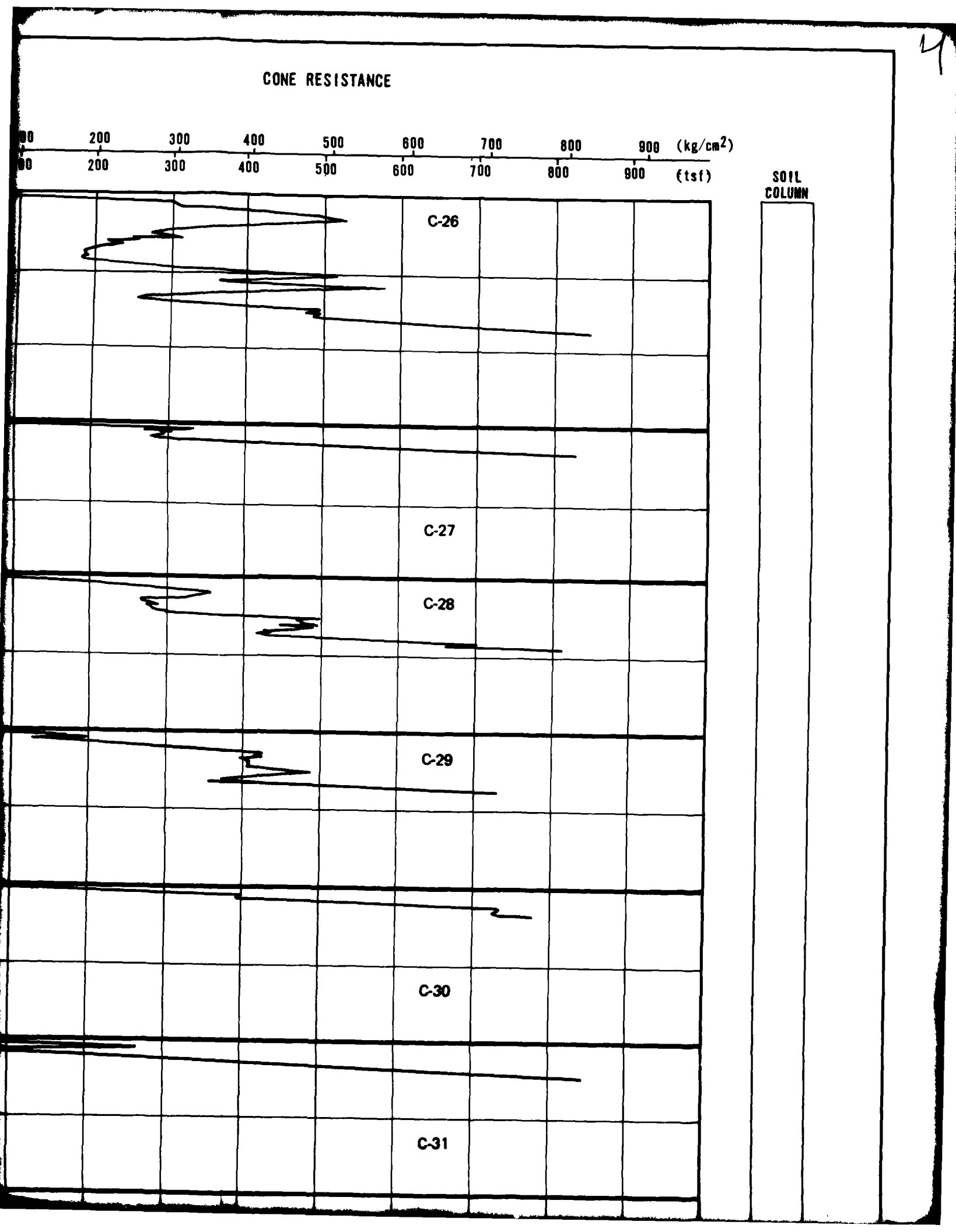
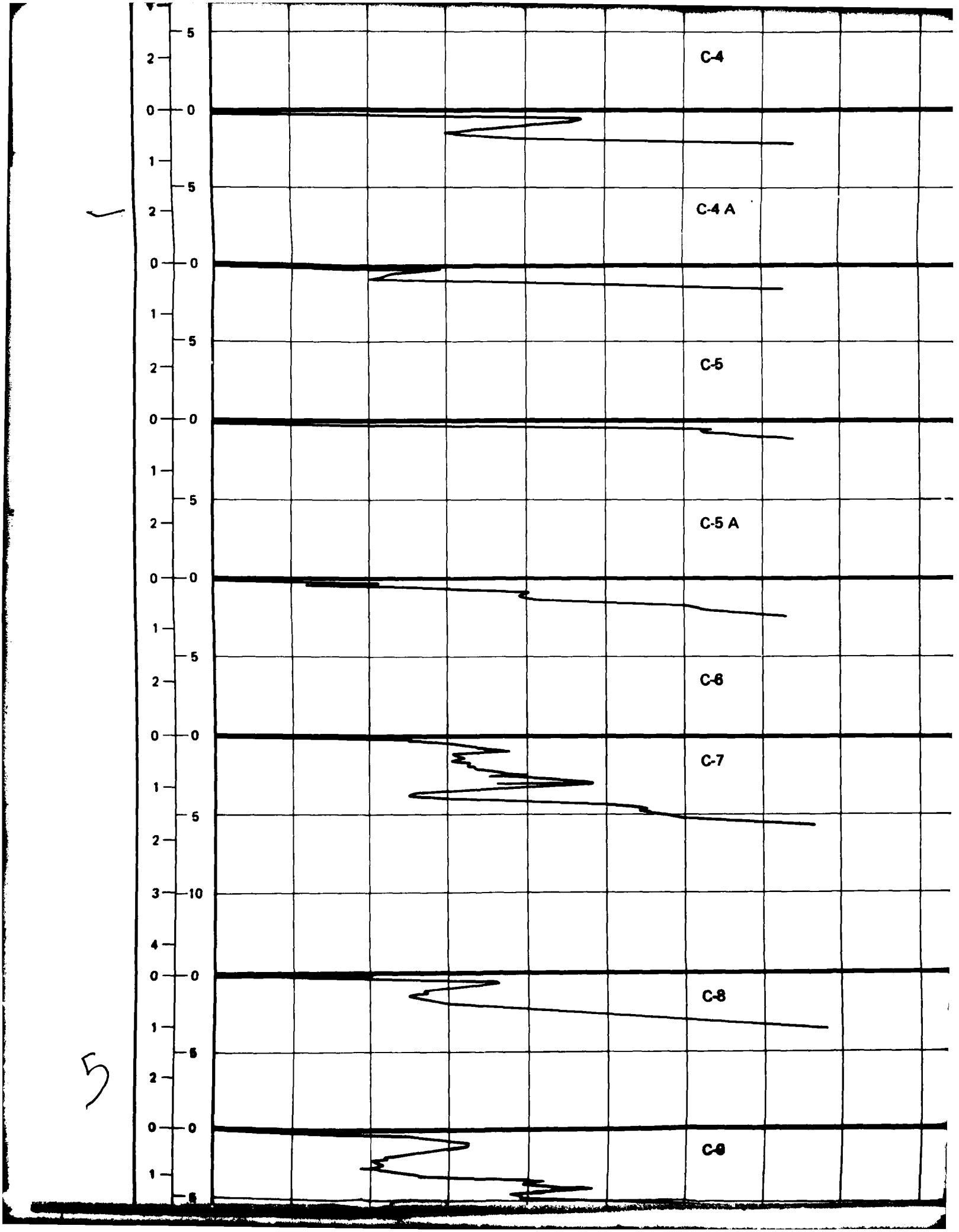
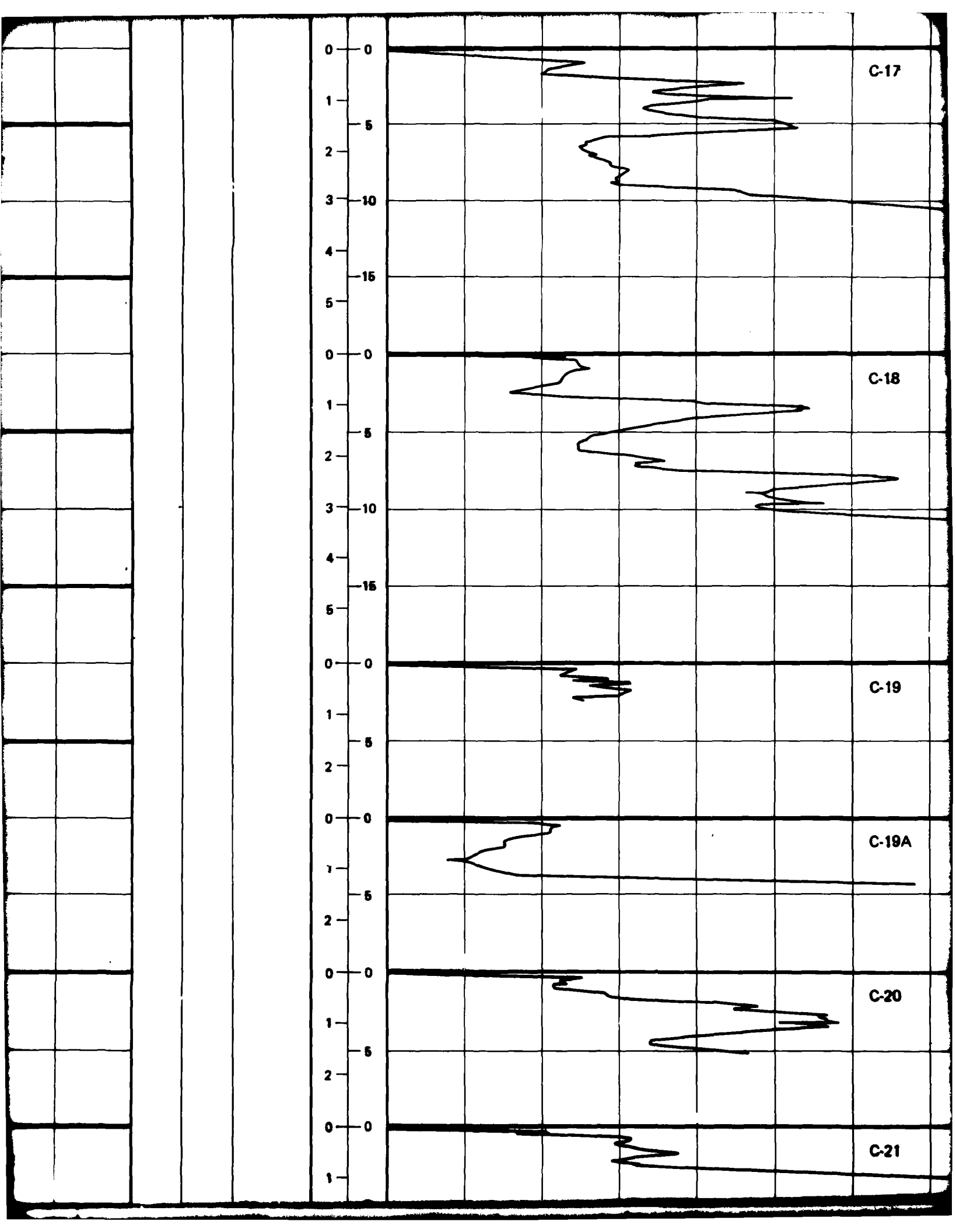
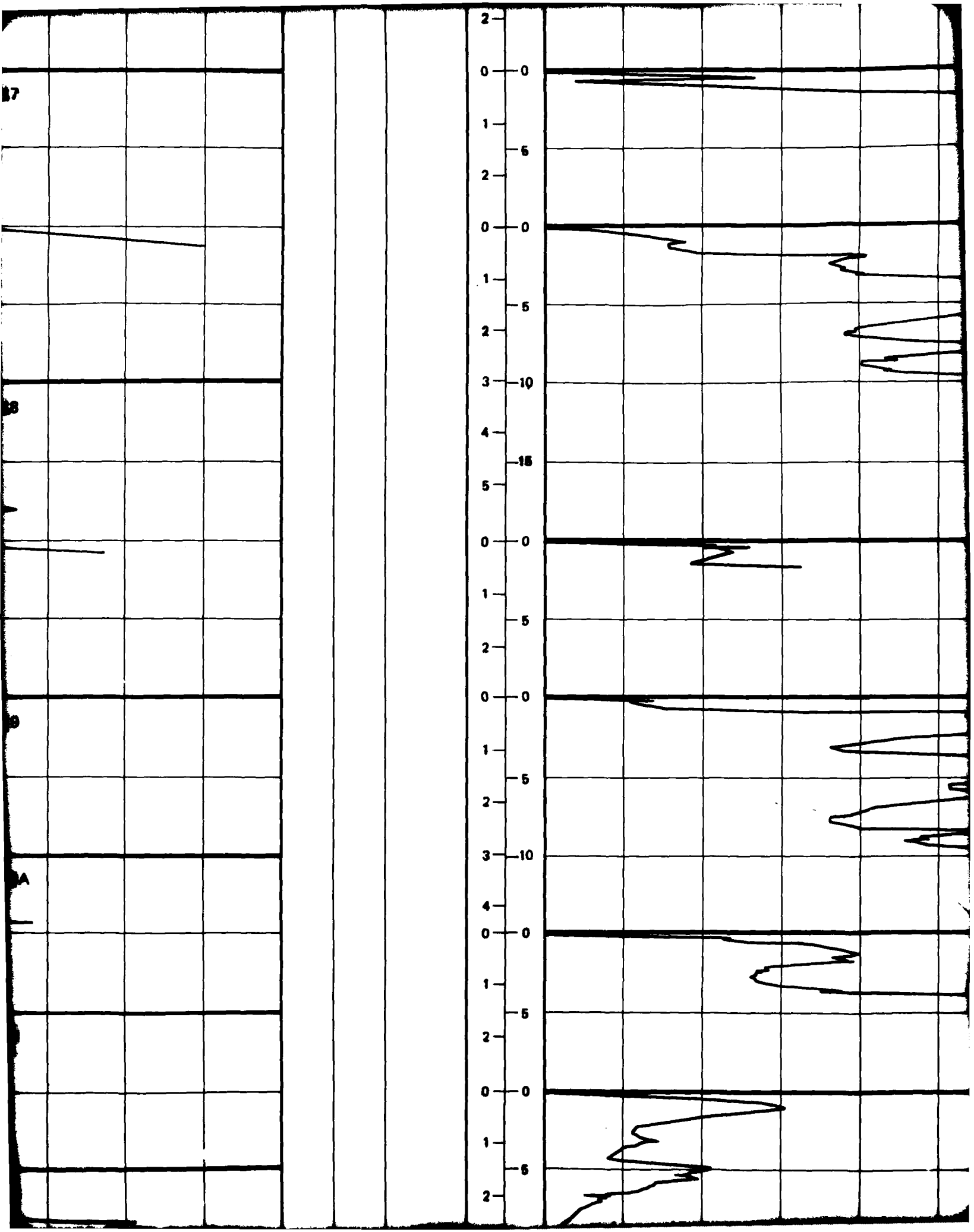
5
0
5
0
5
0
5
0
5


CONE RESISTANCE
200
300
400
500
600
700
800
900
(kg/cm2)
200
300
400
500
600
700
800
900
(tsf)
SOIL COLUMN
C-26
C-27
C-28
C-29
C-30
C-31


C-4
C-4 A
C-5
C-5 A
C-6
C-7
C-8
C-9


C-17
C-18
C-19
C-19A
C-20
C-21


2
0
0
1
5
2
0
0
1
5
2
3
10
4
15
5
0
0
1
5
2
0
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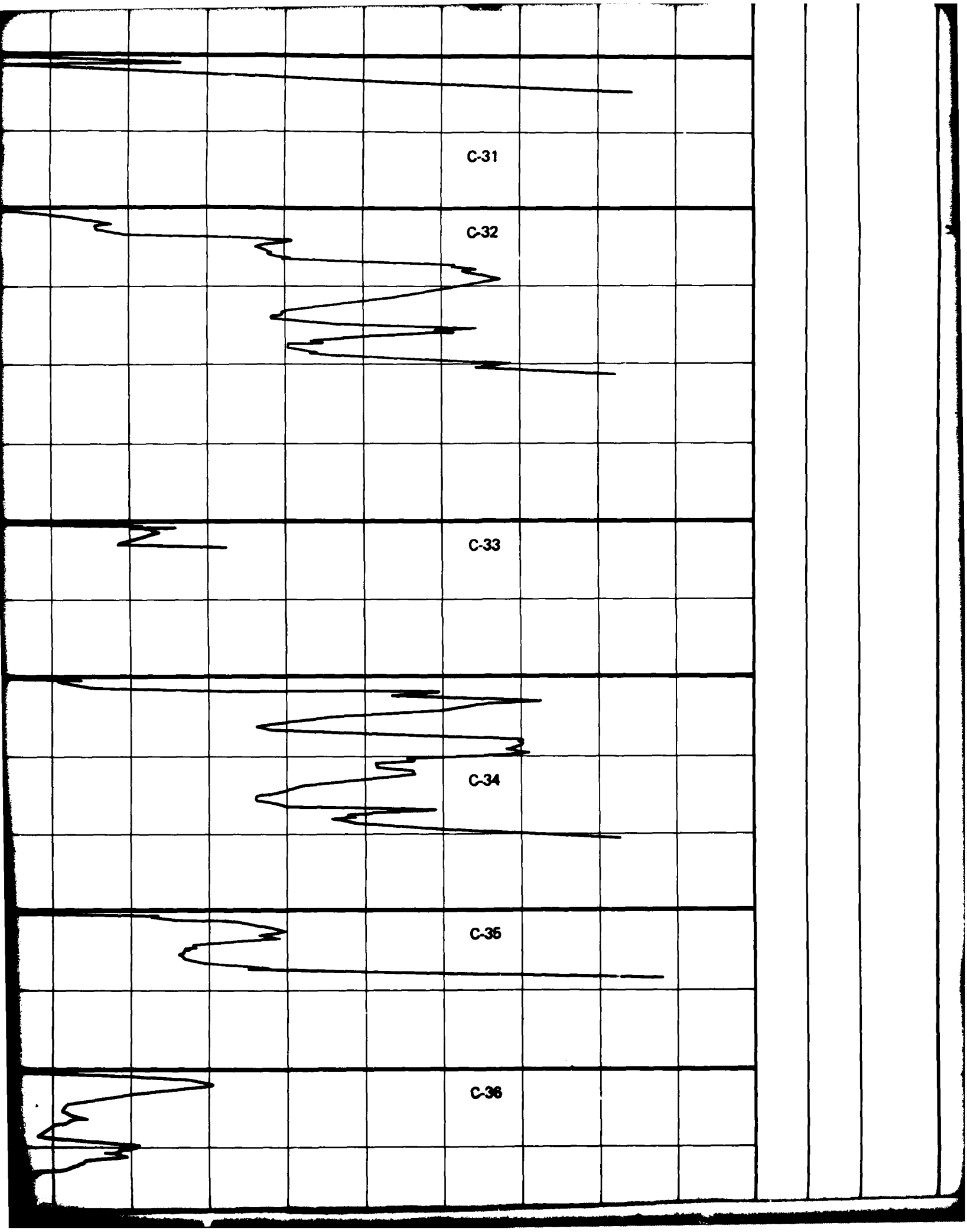
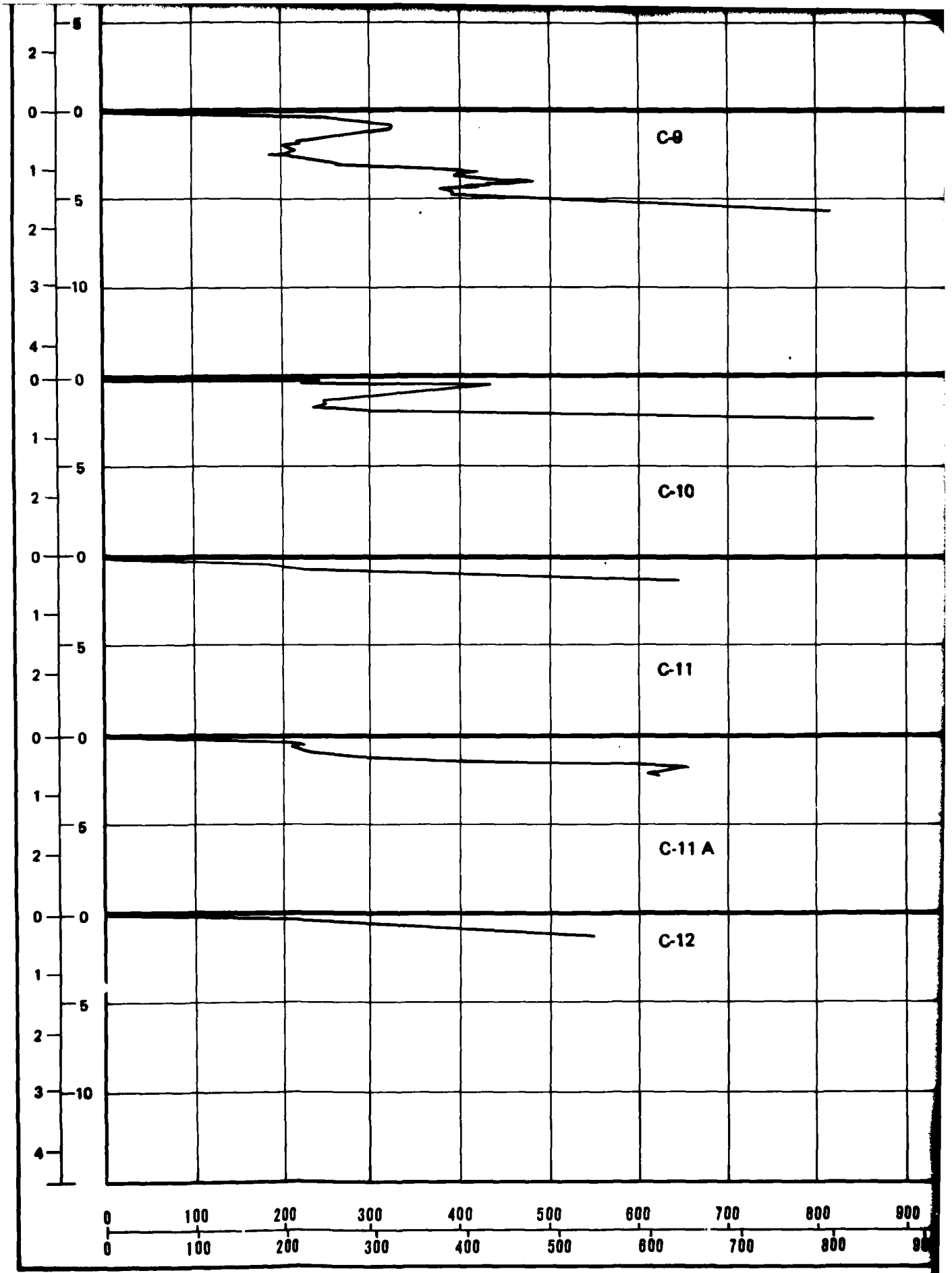
1
5
2
3
10
4
0
0
1
5
2
0
0
1
5
2

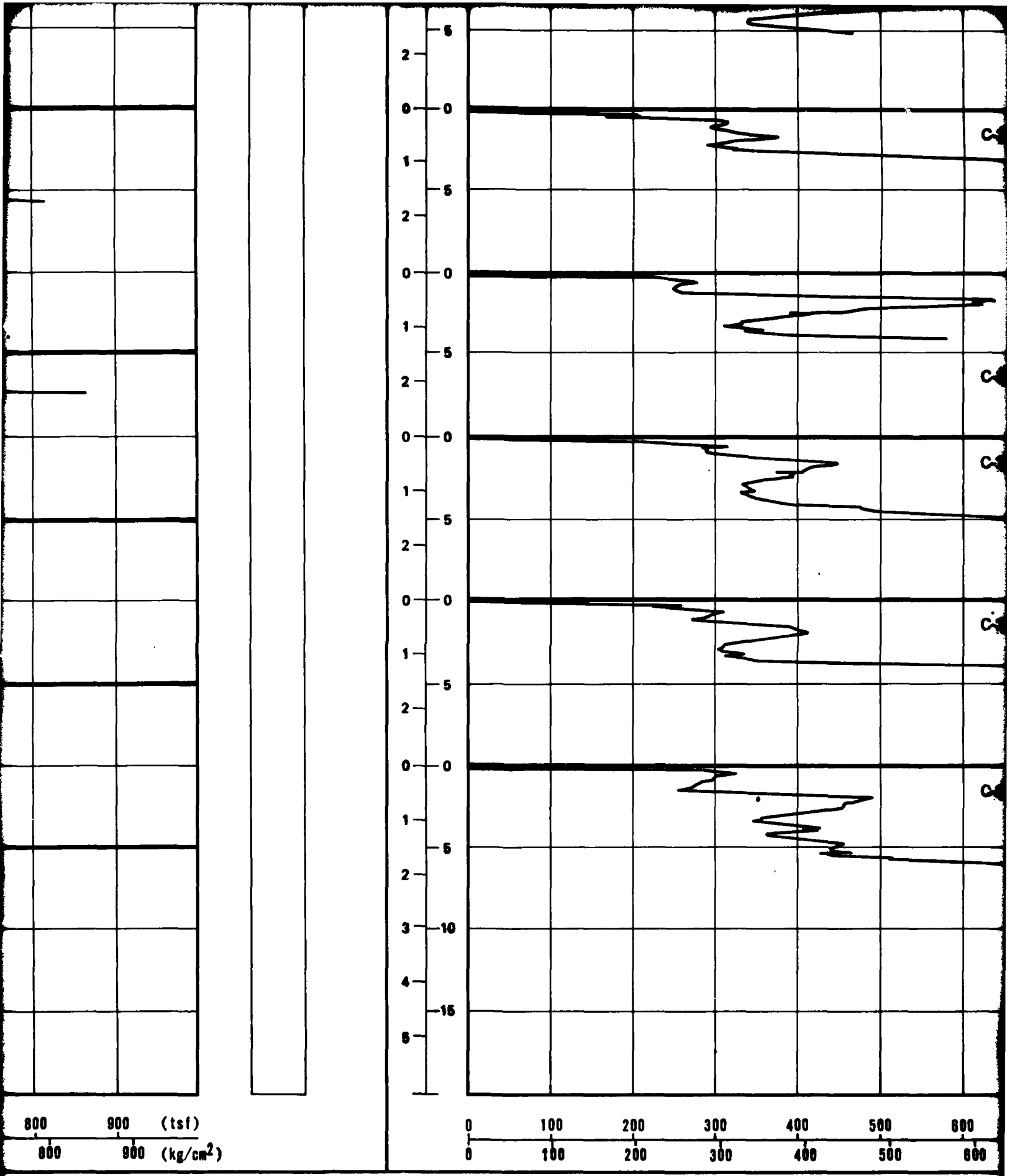

C-31
C-32
C-33
C-34
C-35
C-36

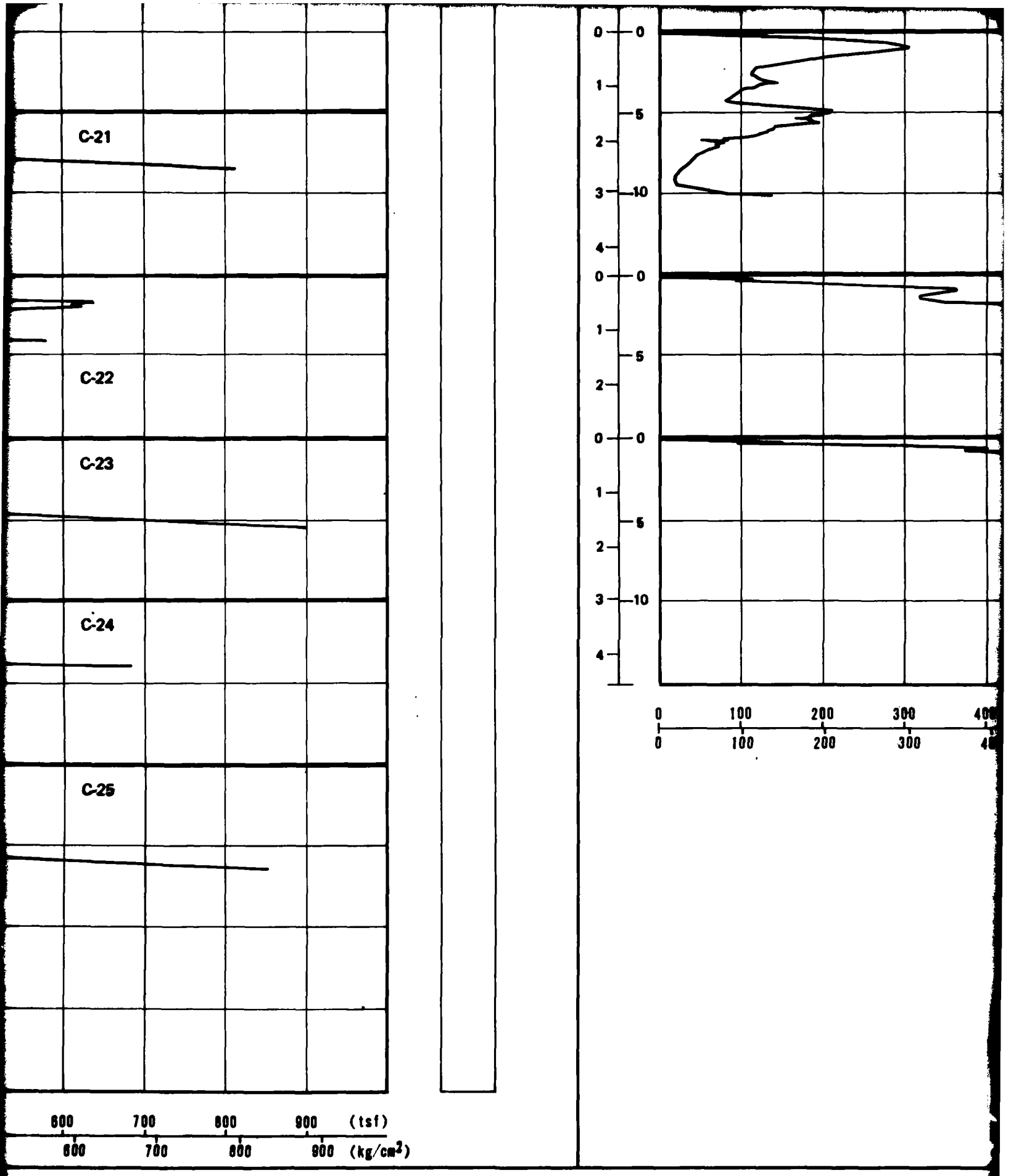
5

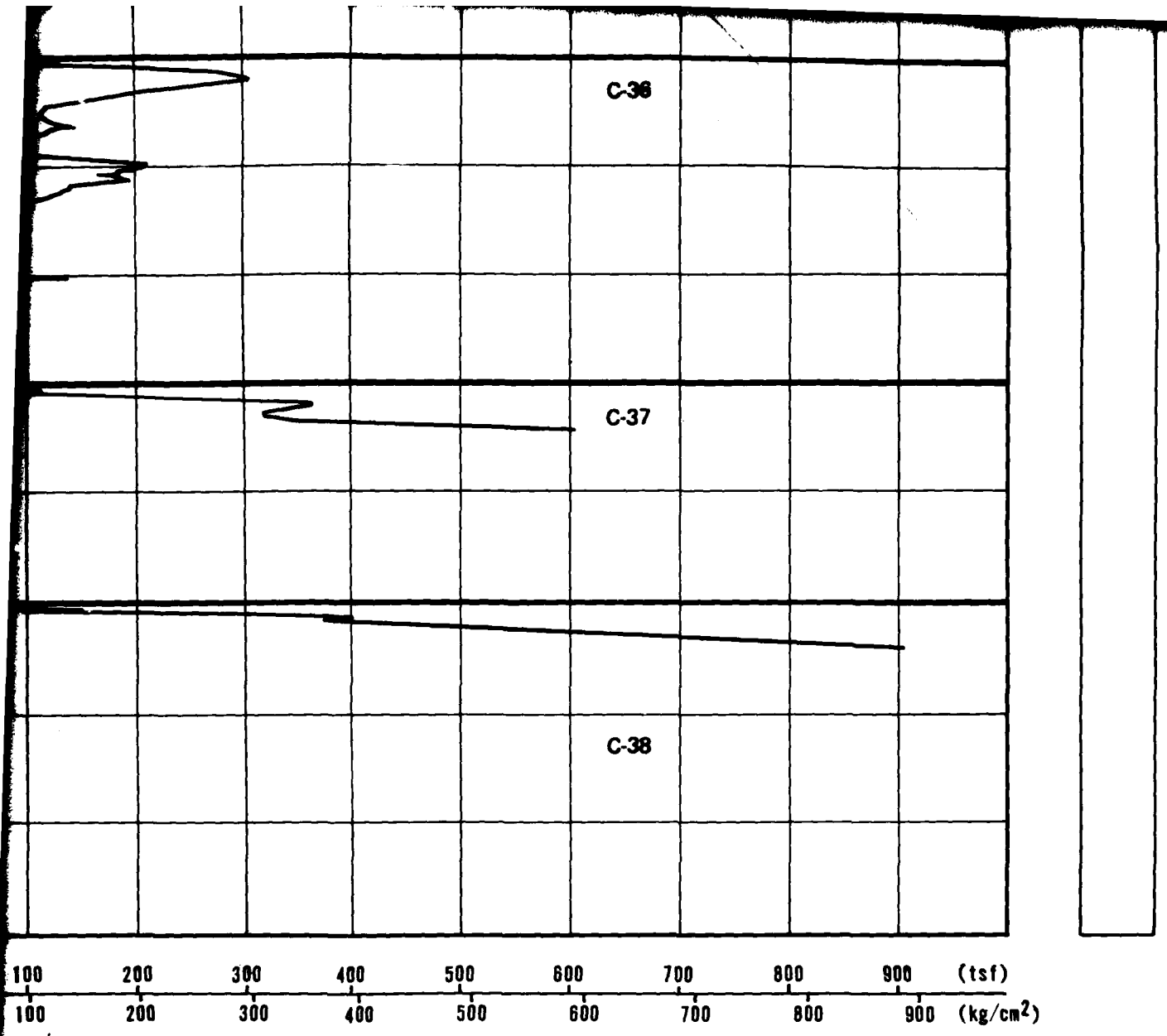


CHECKED BY _____ APPROVED BY _____

9


800
900
(tsf)
800
900
(kg/cm²)
0
100
200
300
400
500
600
0
100
200
300
400
500
600


C-21
C-22
C-23
C-24
C-25
600
700
800
900
(tsf)
600
700
800
900
(kg/cm²)
0
1
2
3
4
0
5
10
0
100
200
300
400



CONE PENETROMETER TEST RESULTS, TEST TRACK B, ETB MOBILITY STUDY, NEVADA TEST SITE, NEVADA

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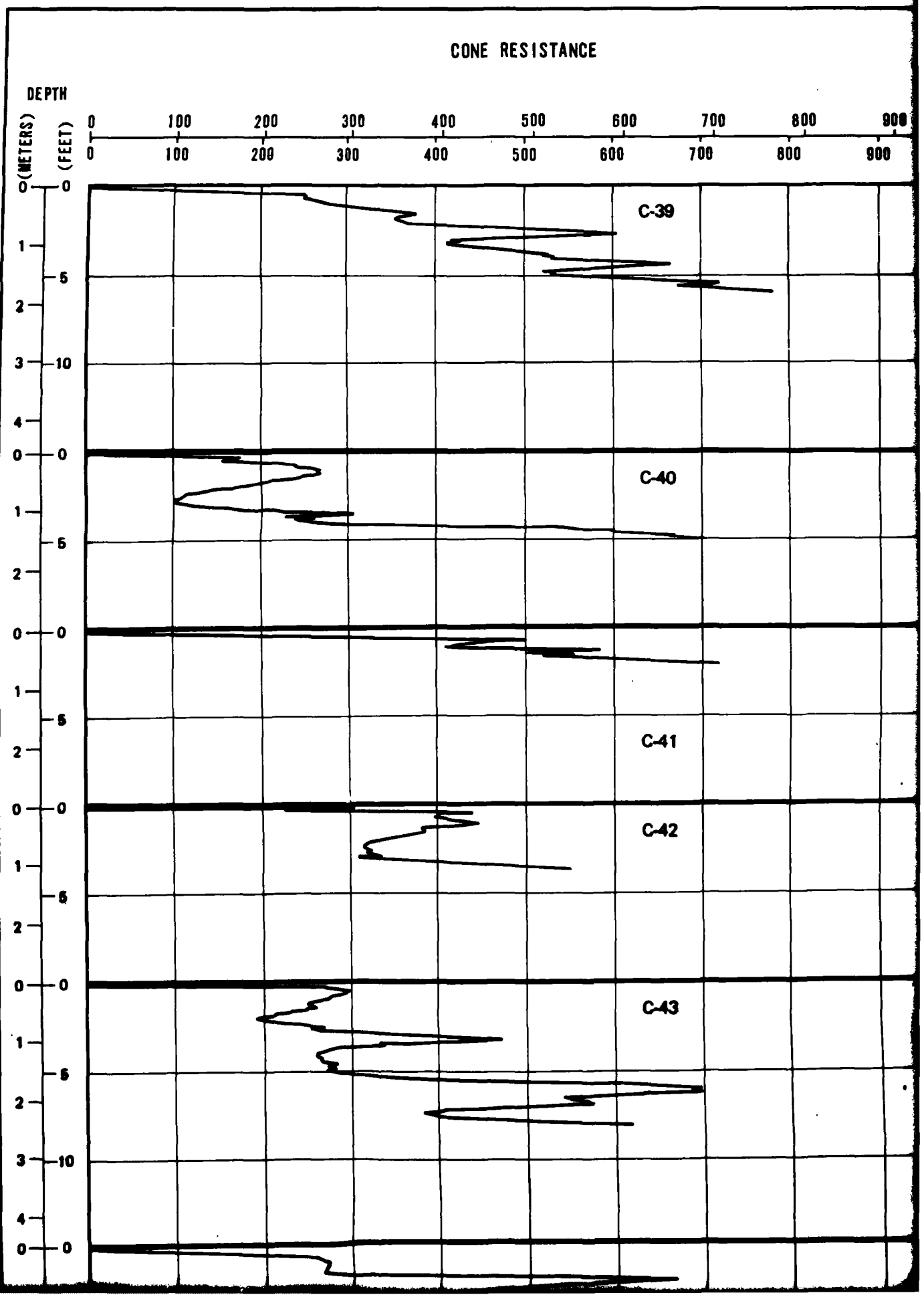
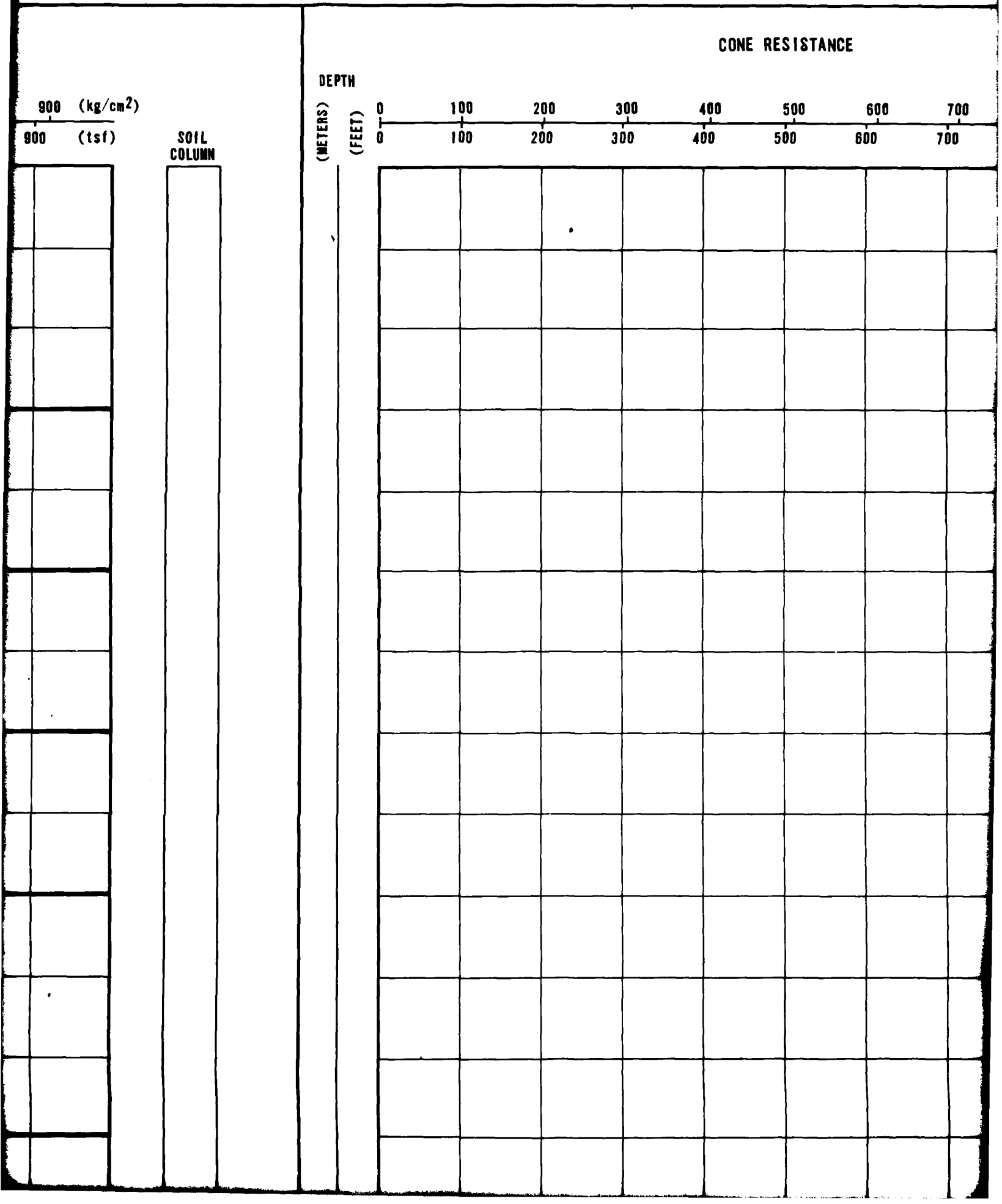
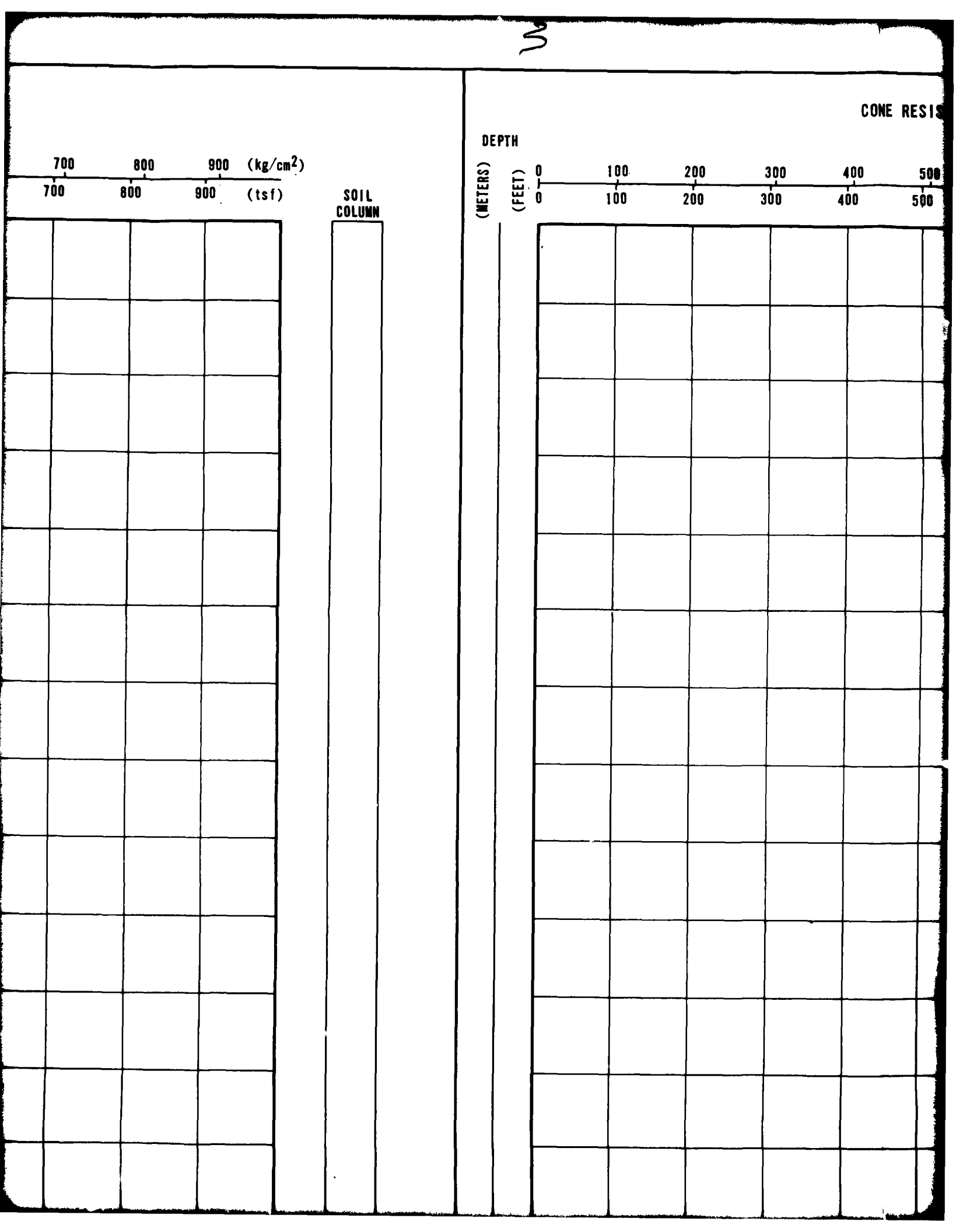

CONE RESISTANCE
DEPTH
(METERS)
(FEET)
0
100
200
300
400
500
600
700
800
900
C-39
C-40
C-41
C-42
C-43

2


CONE RESISTANCE
DEPTH
(METERS)
(FEET)
900 (kg/cm2)
900 (tsf)
SOIL COLUMN
0 100 200 300 400 500 600 700
0 100 200 300 400 500 600 700

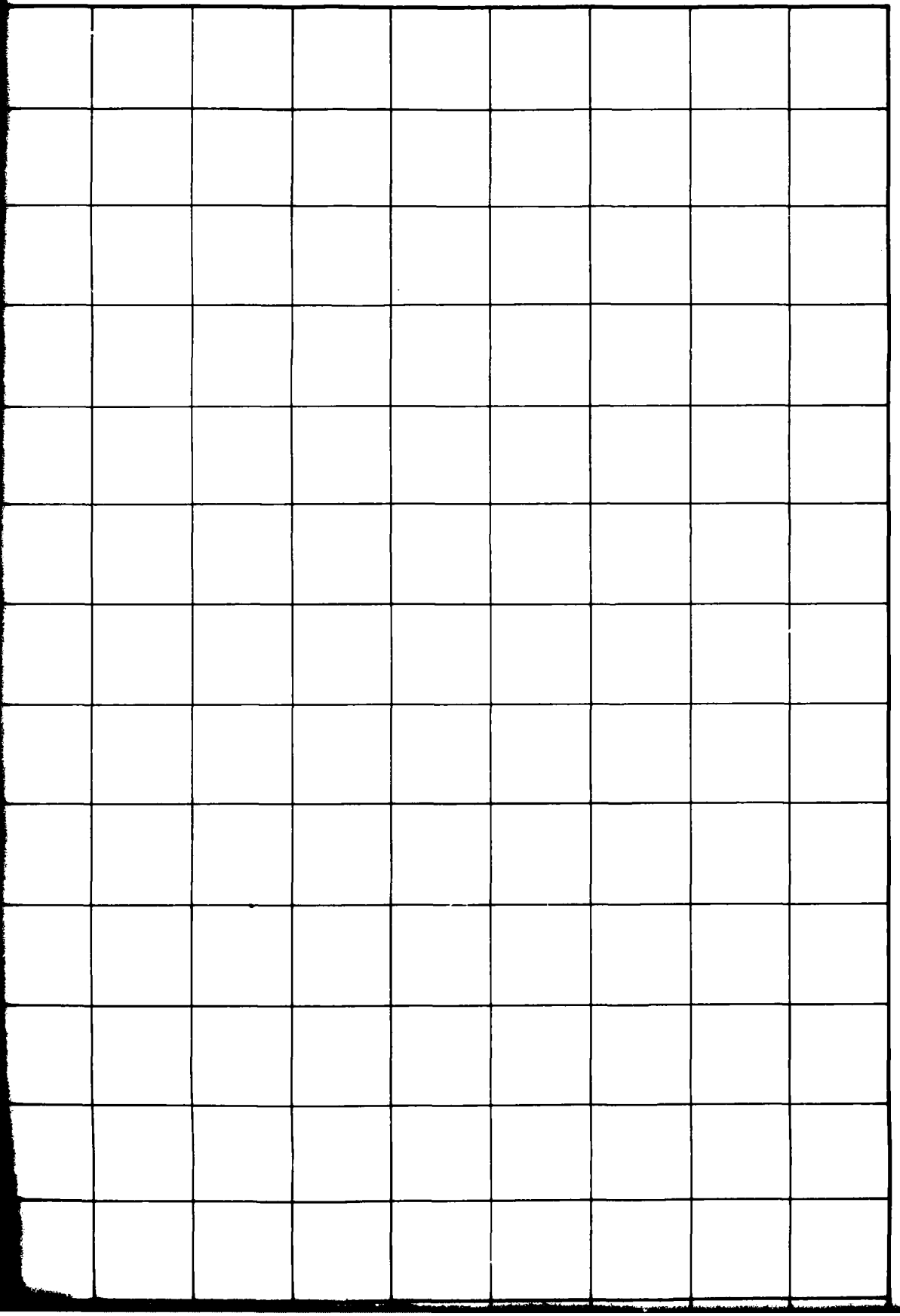

700
800
900
(kg/cm2)
700
800
900
(tsf)
SOIL COLUMN
DEPTH
(METERS)
(FEET)
0
100
200
300
400
500
0
100
200
300
400
500

CONE RESISTANCE

200 300 400 500 600 700 800 900 (kg/cm^2)

200 300 400 500 600 700 800 900 (tsf)

SOIL COLUMN



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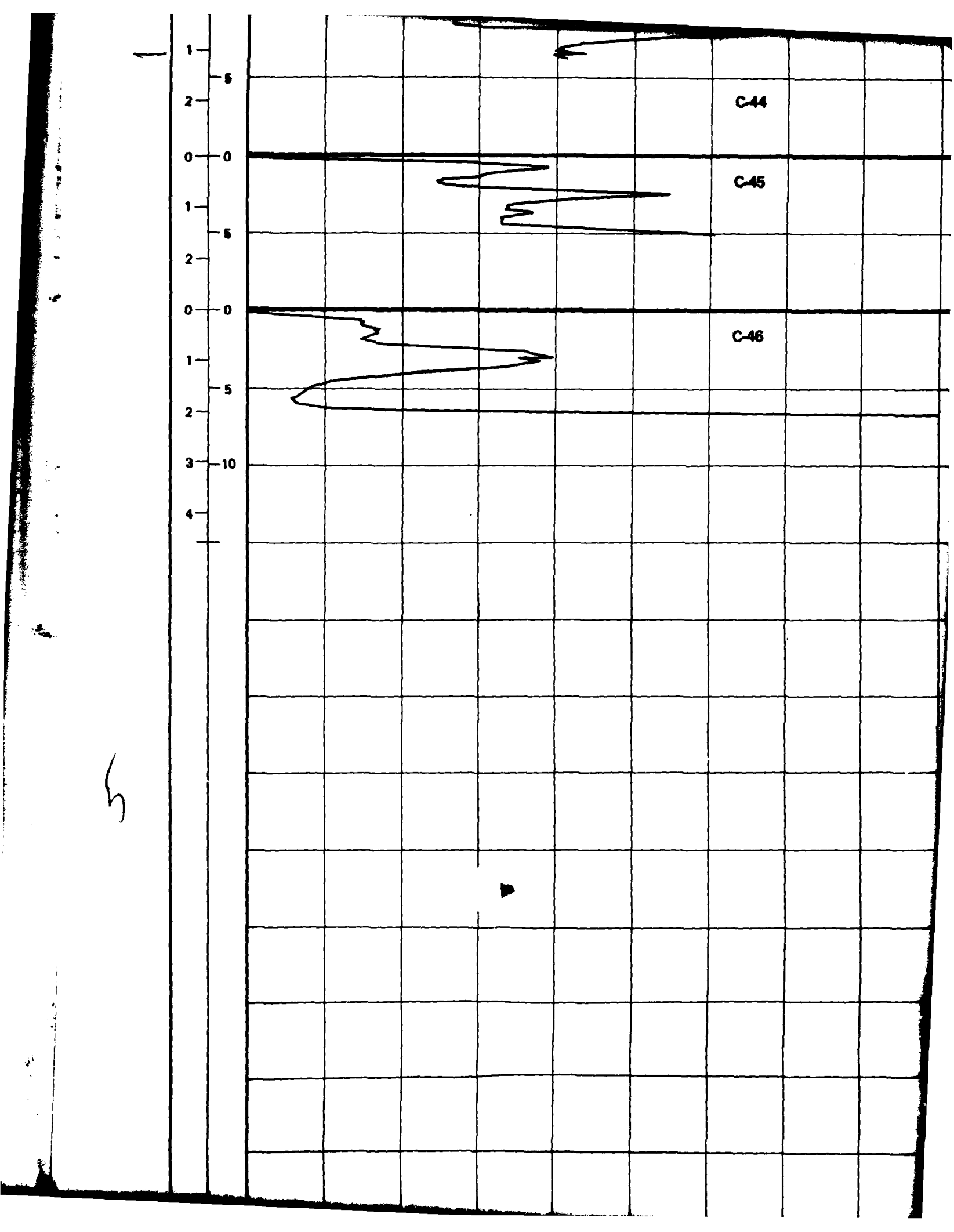
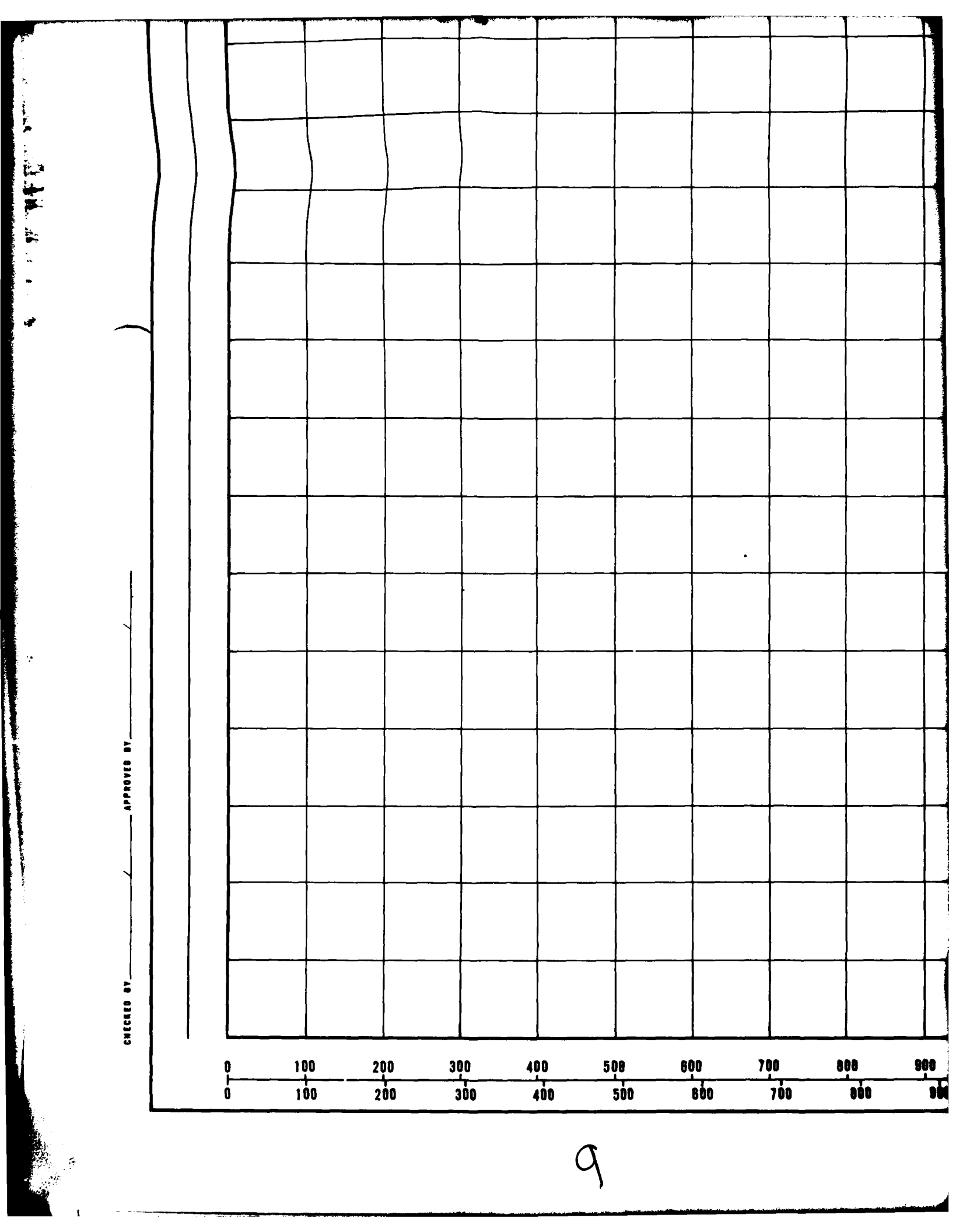
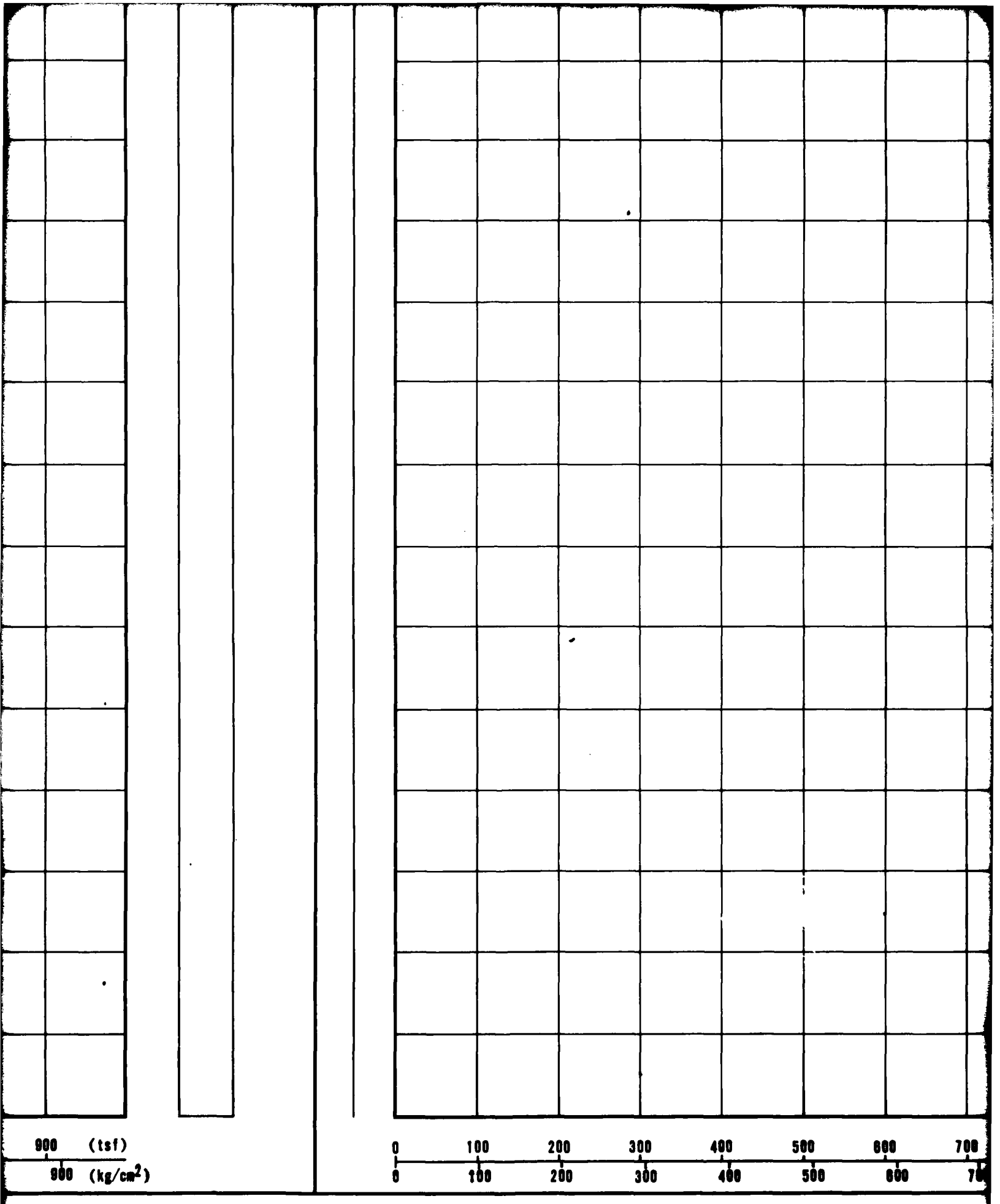
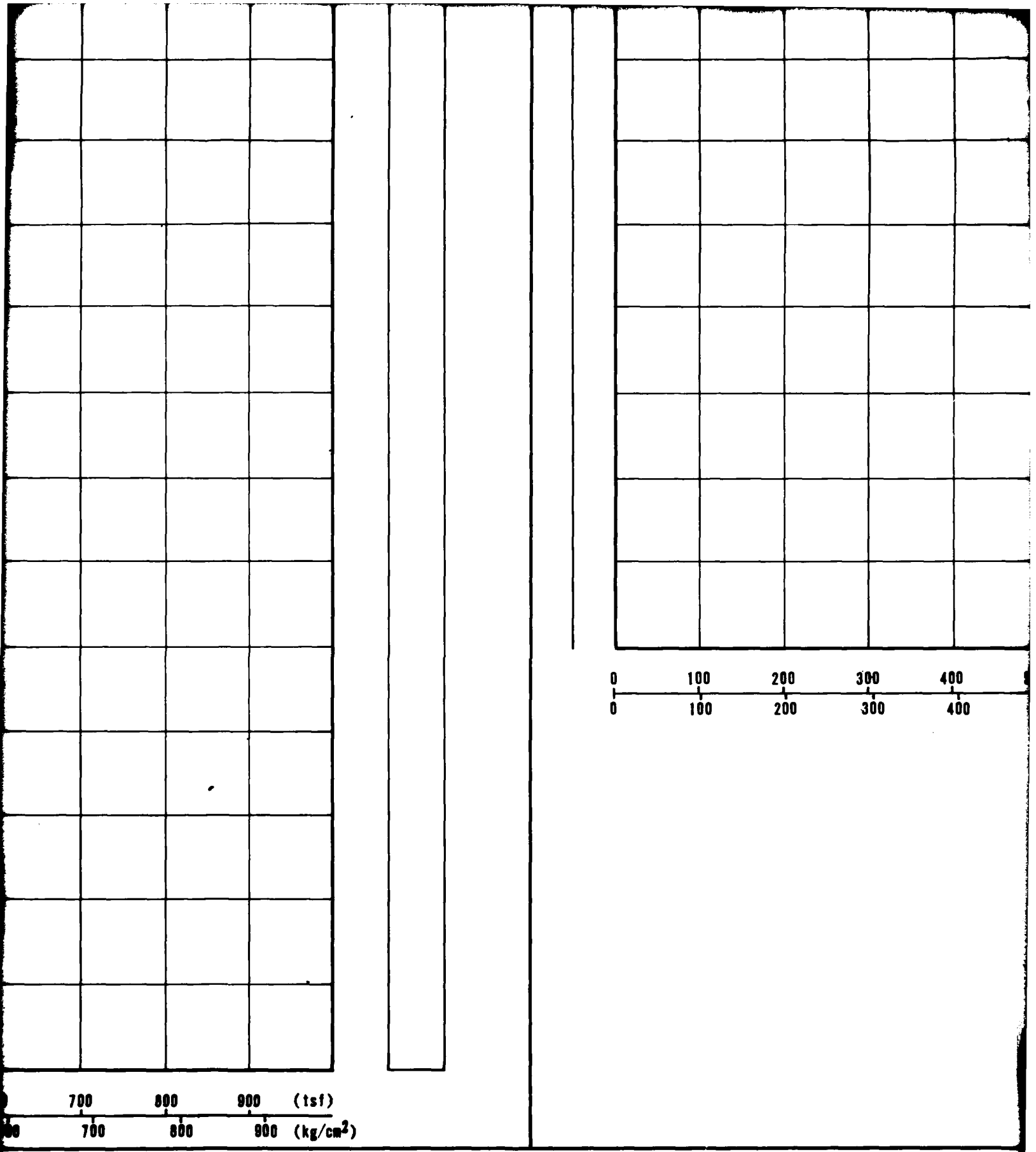
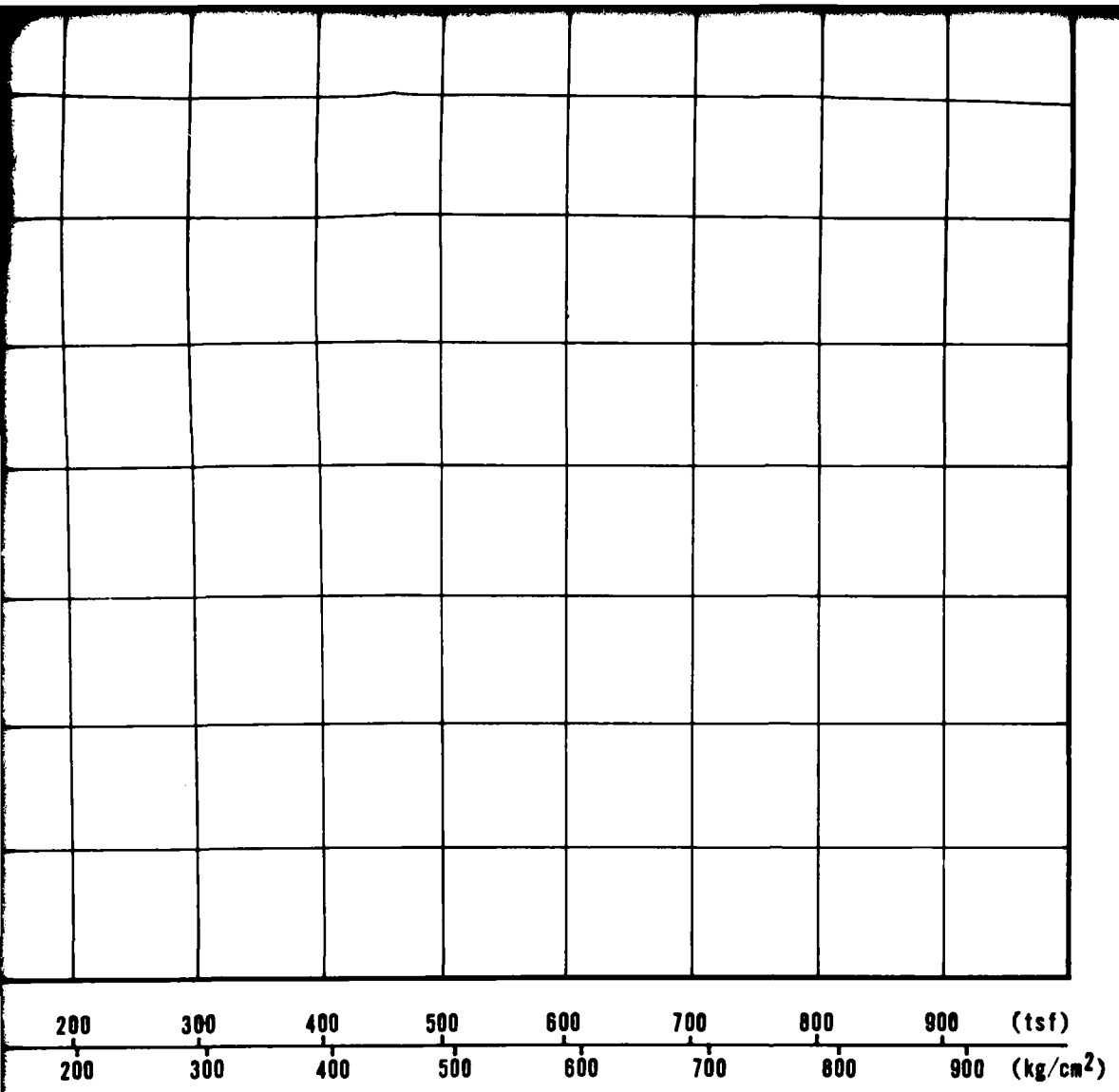

1
5
2
0
0
1
5
2
0
0
1
5
2
3
10
4
C-44
C-45
C-46


CHECKED BY
APPROVED BY
0
100
200
300
400
500
600
700
800
900


900 (tsf)
900 (kg/cm²)
0 100 200 300 400 500 600 700
0 100 200 300 400 500 600


0 100 200 300 400
0 100 200 300 400
700 800 900 (tsf)
700 800 900 (kg/cm²)



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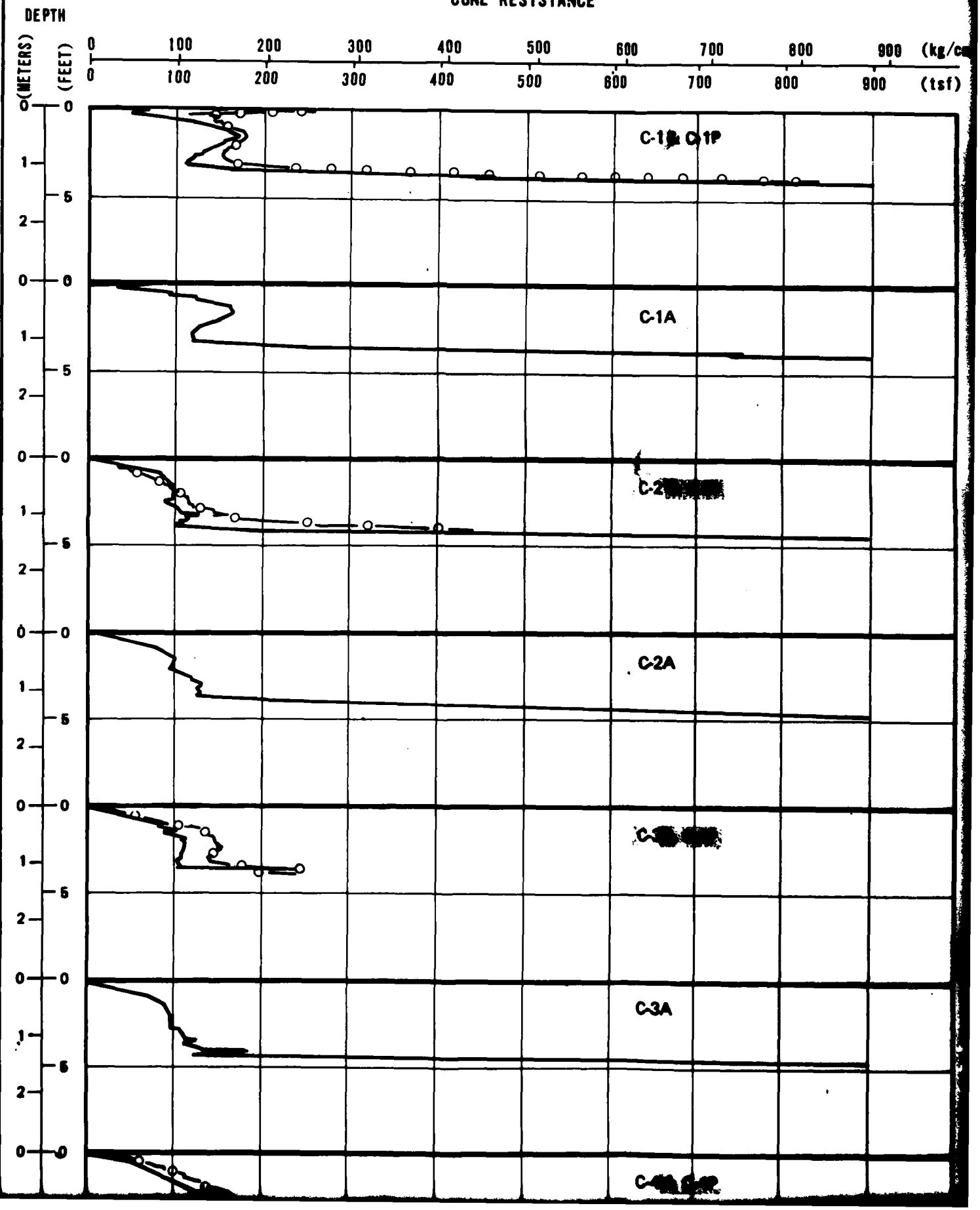
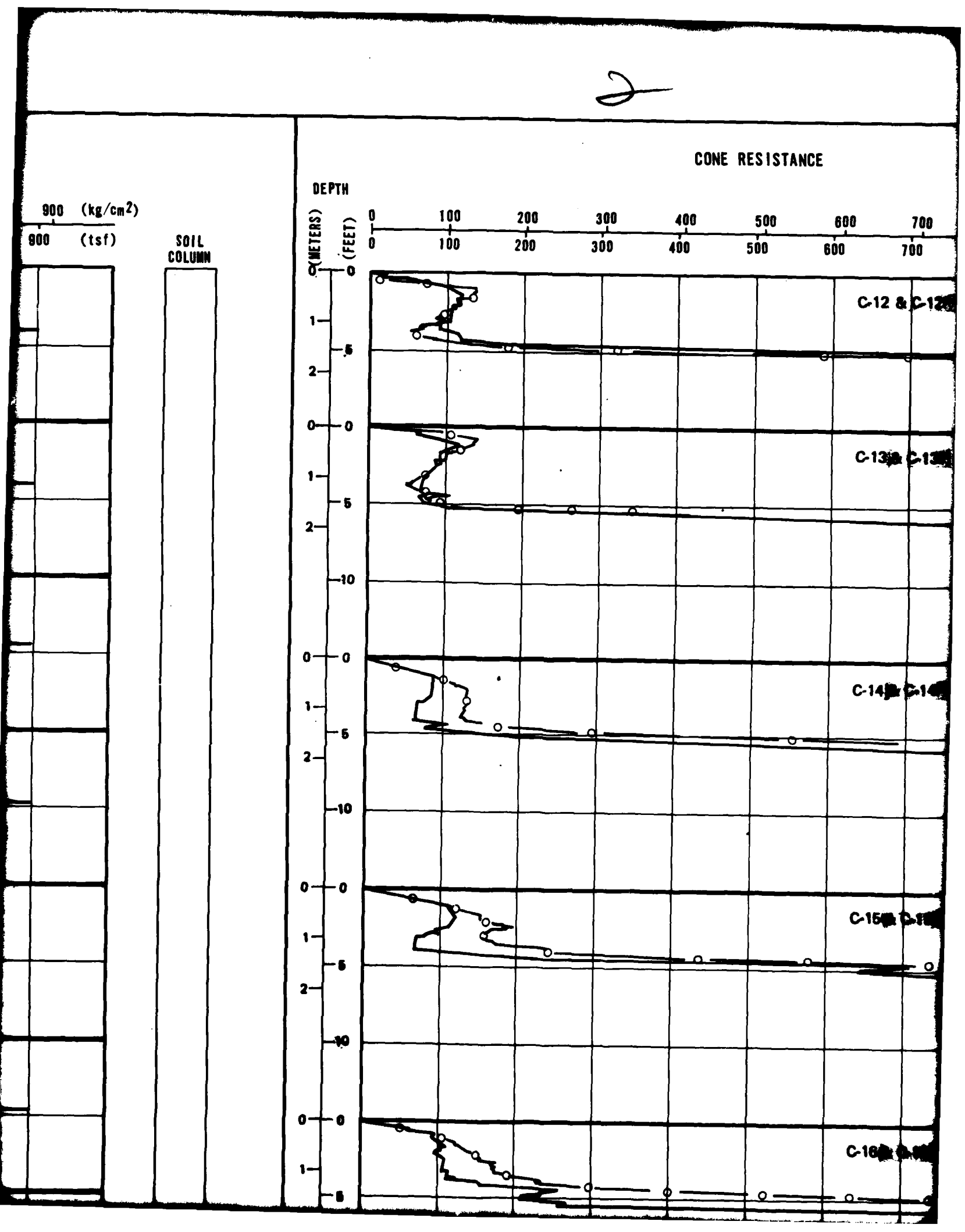
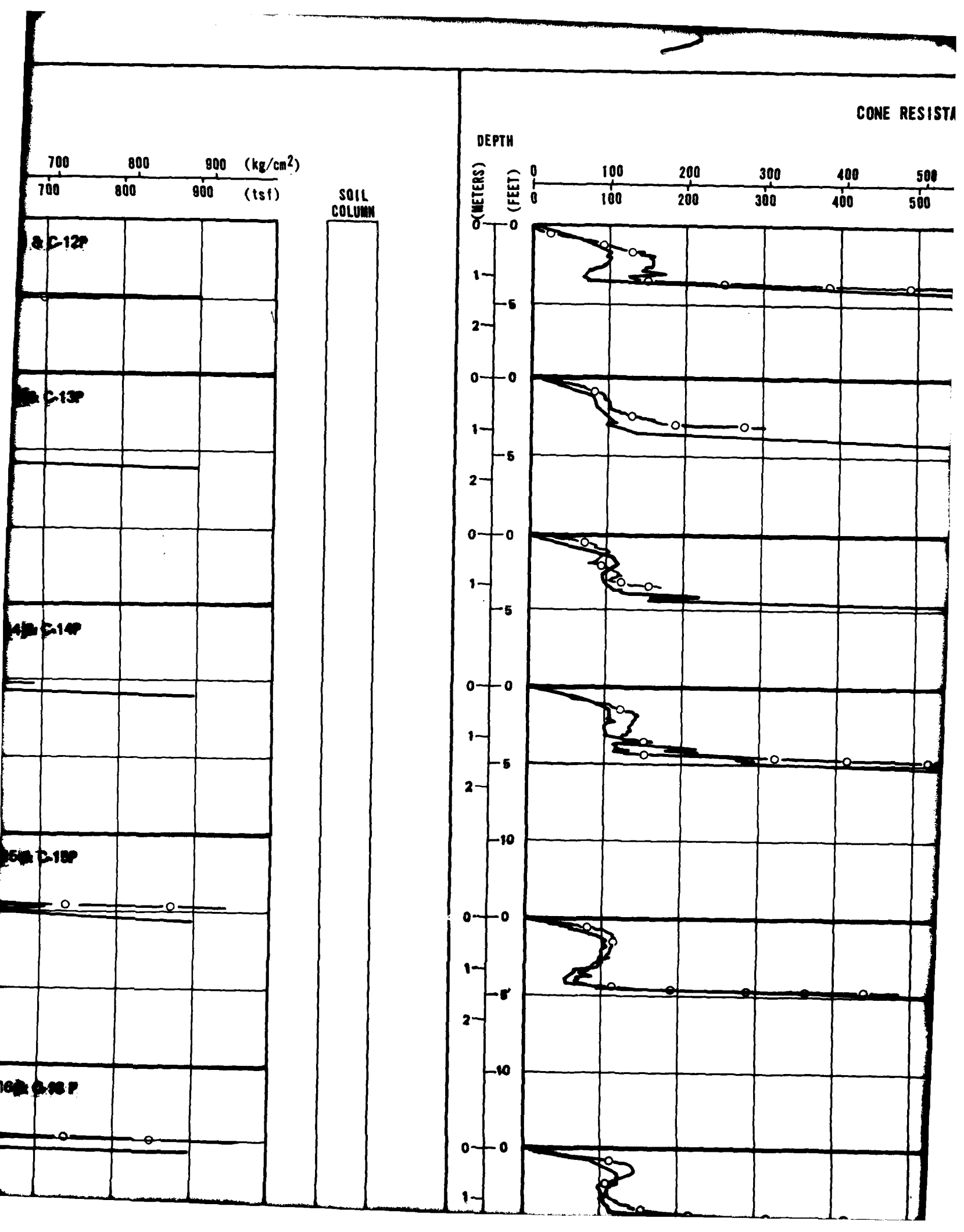
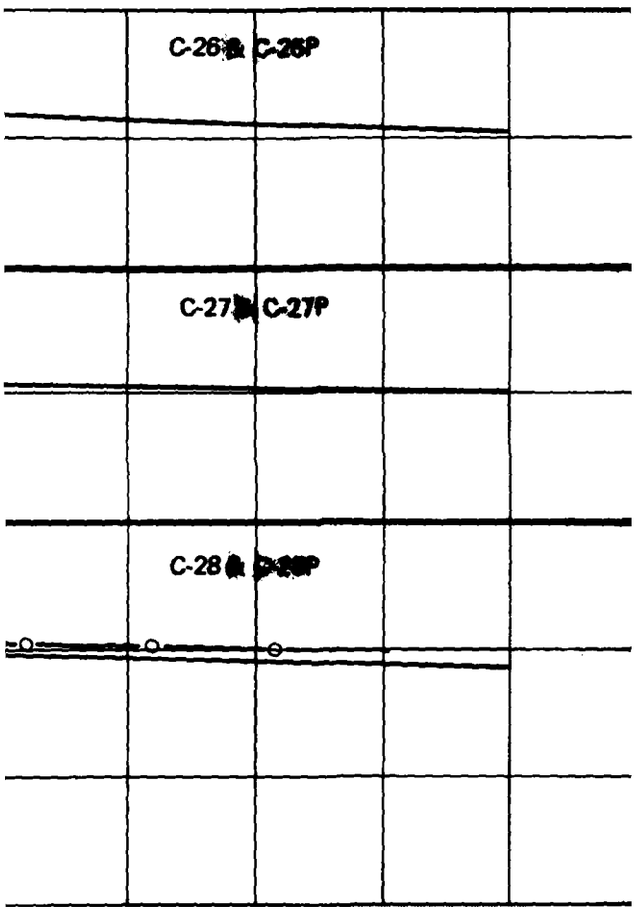
TEST TRACK C

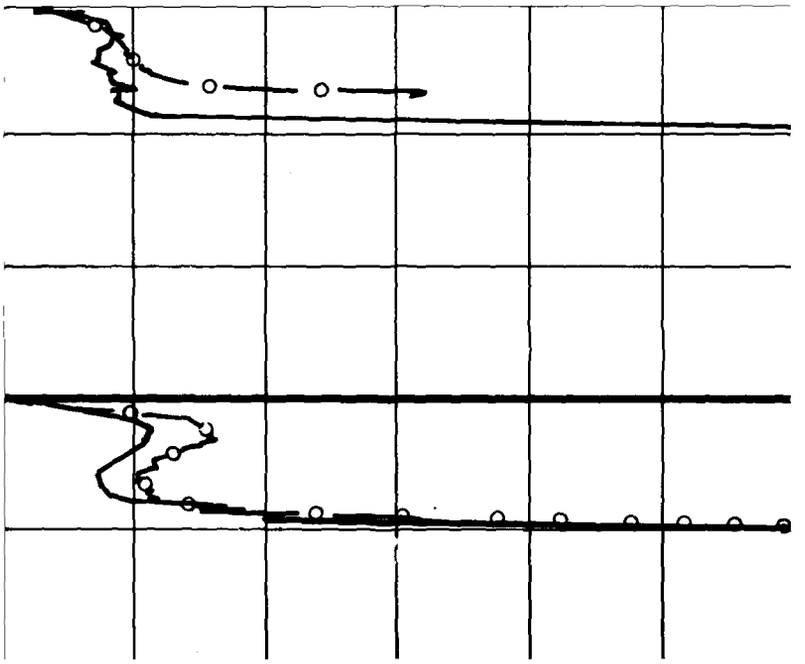
CONE RESISTANCE

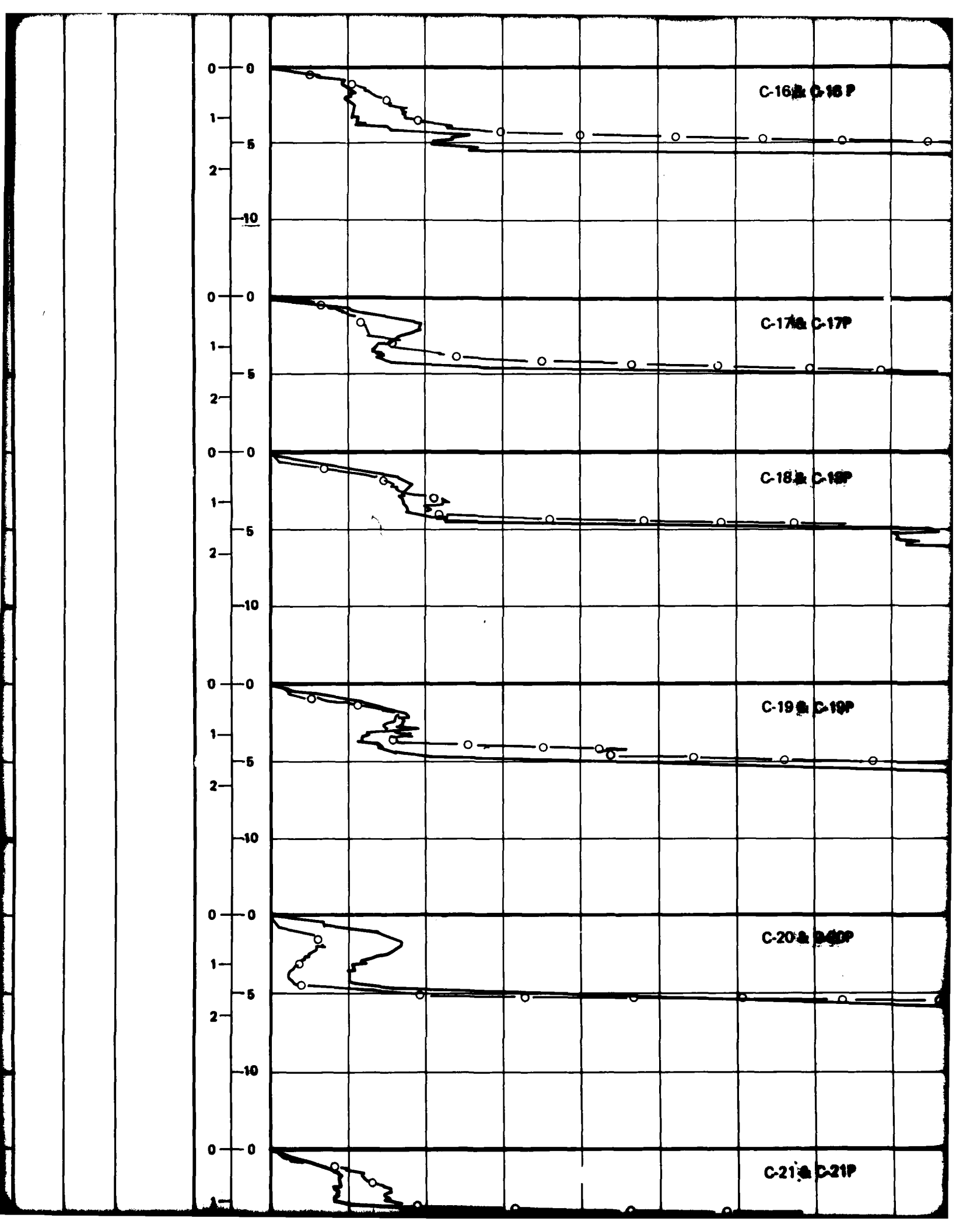


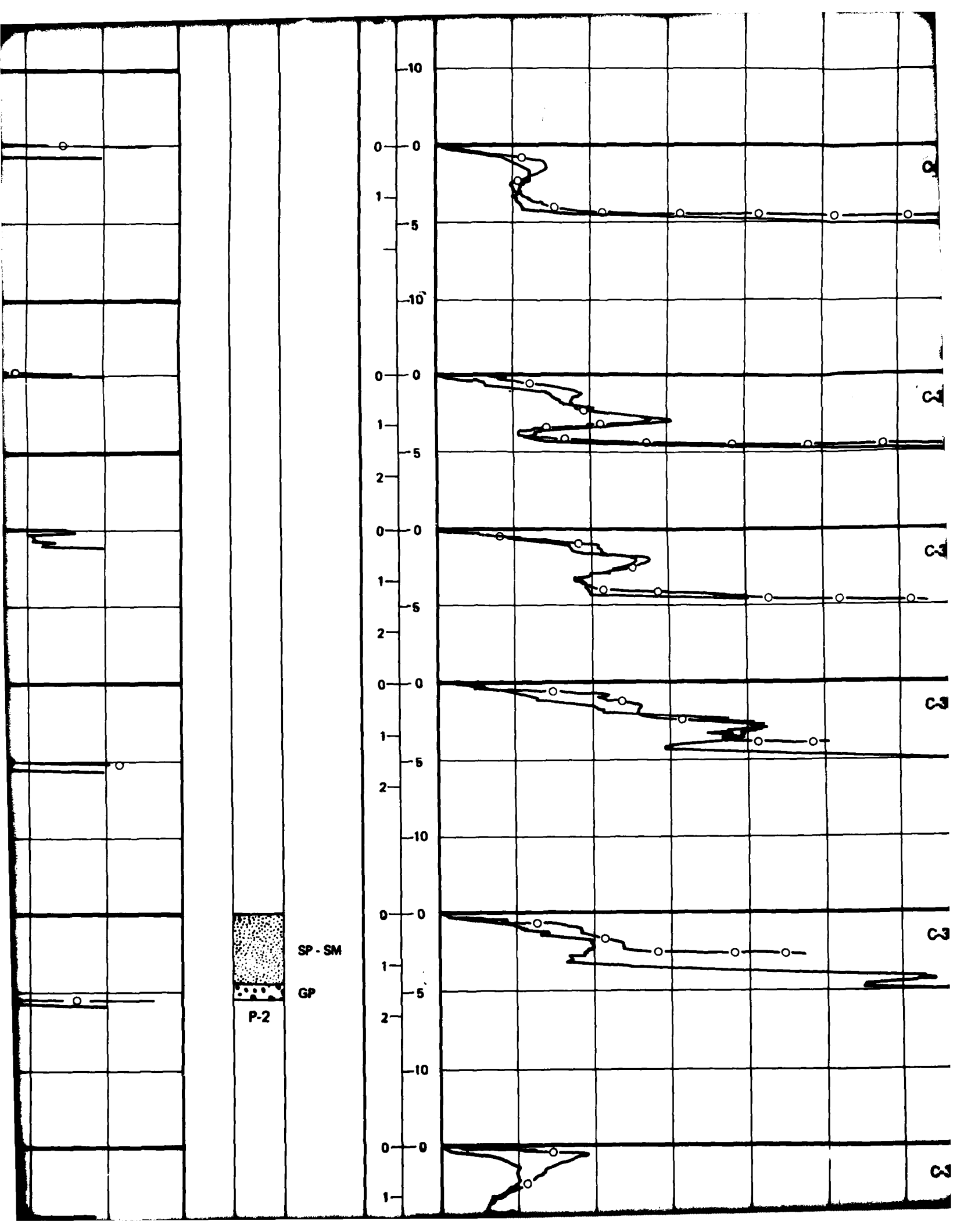

900 (kg/cm²)
900 (tsf)
SOIL COLUMN
CONE RESISTANCE
DEPTH
(METERS)
(FEET)
0 100 200 300 400 500 600 700
0 100 200 300 400 500 600 700
C-12 &
C-13
C-14
C-15
C-16

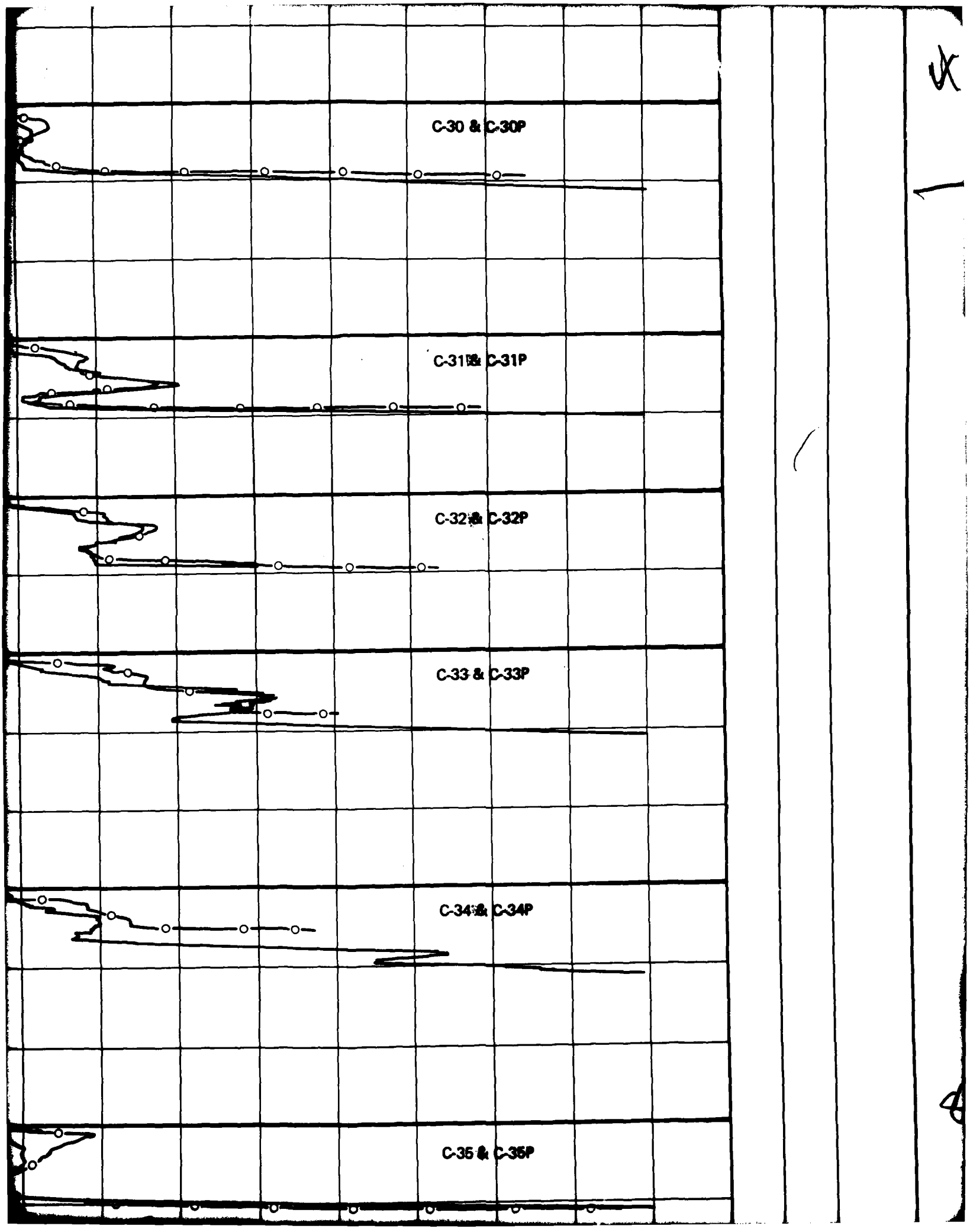

CONE RESISTA
DEPTH
(METERS)
(FEET)
0
100
200
300
400
500
700
800
900
(kg/cm²)
(tsf)
SOIL COLUMN
C-12P
C-13P
C-14P
C-15P
C-16P

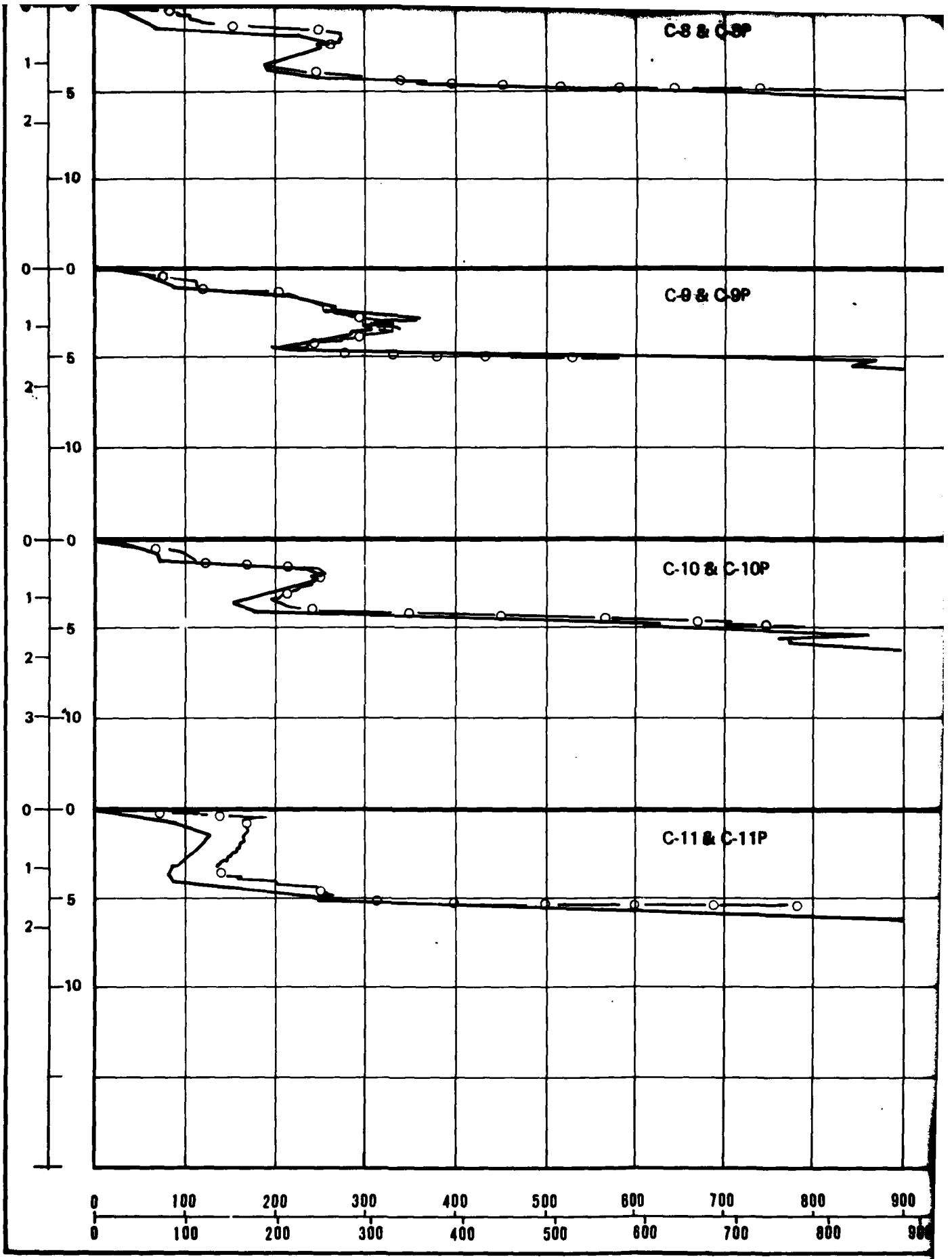

C-26
C-27
C-28




0
0
1
5
2
10
C-16
C-17
C-18
C-19
C-20
C-21


SP - SM
GP
P-2


C-30 & C-30P
C-31 & C-31P
C-32 & C-32P
C-33 & C-33P
C-34 & C-34P
C-35 & C-35P



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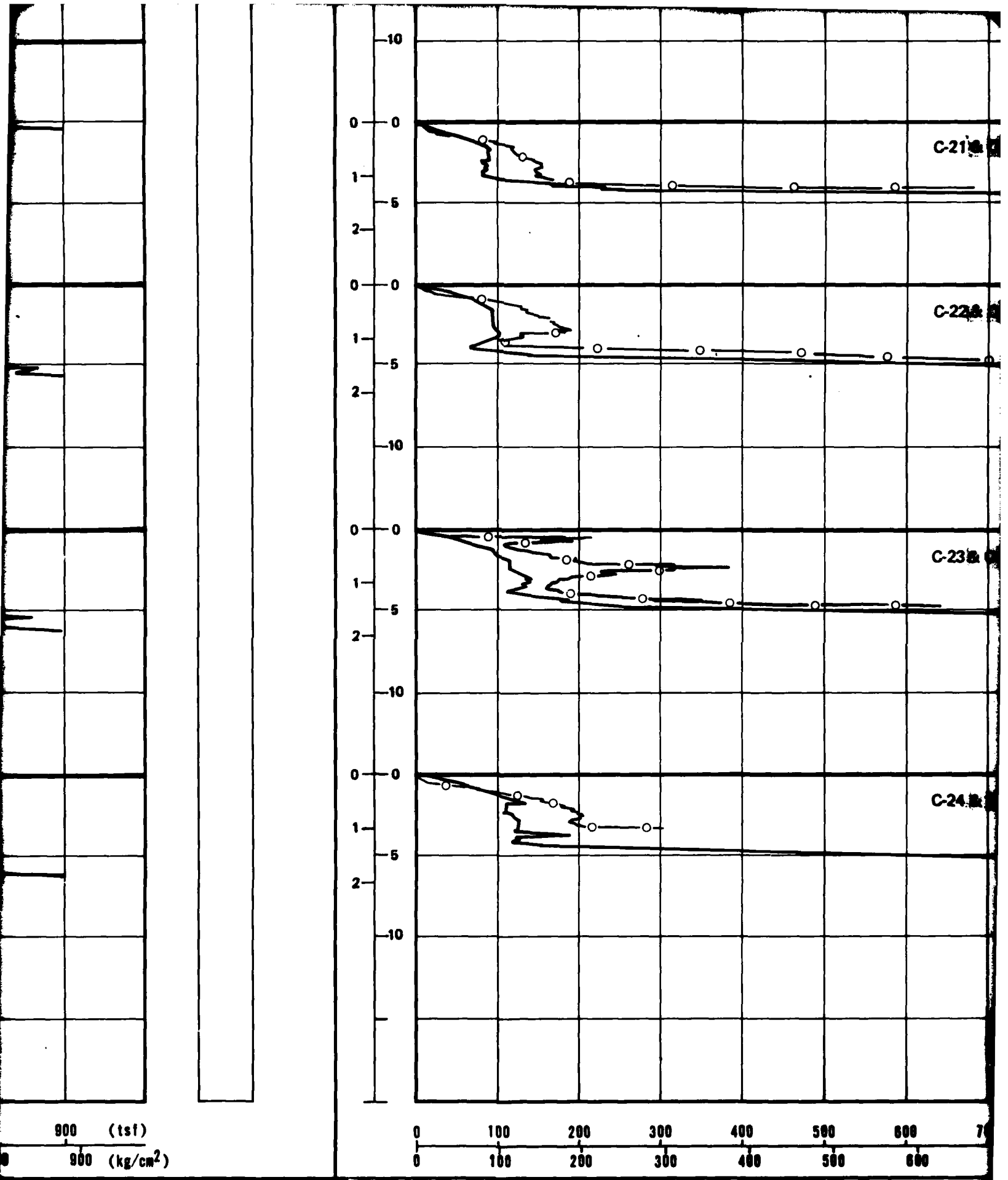
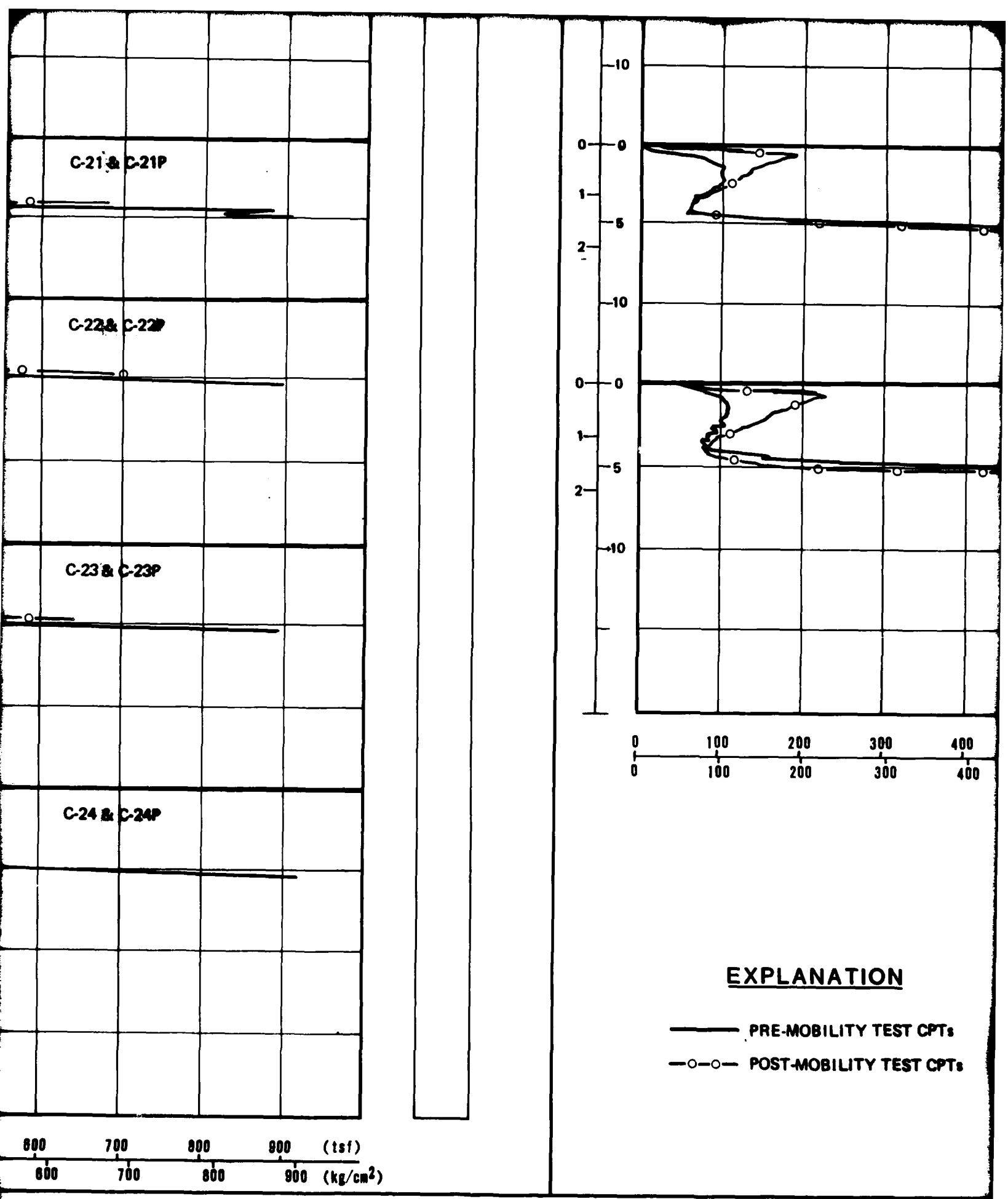
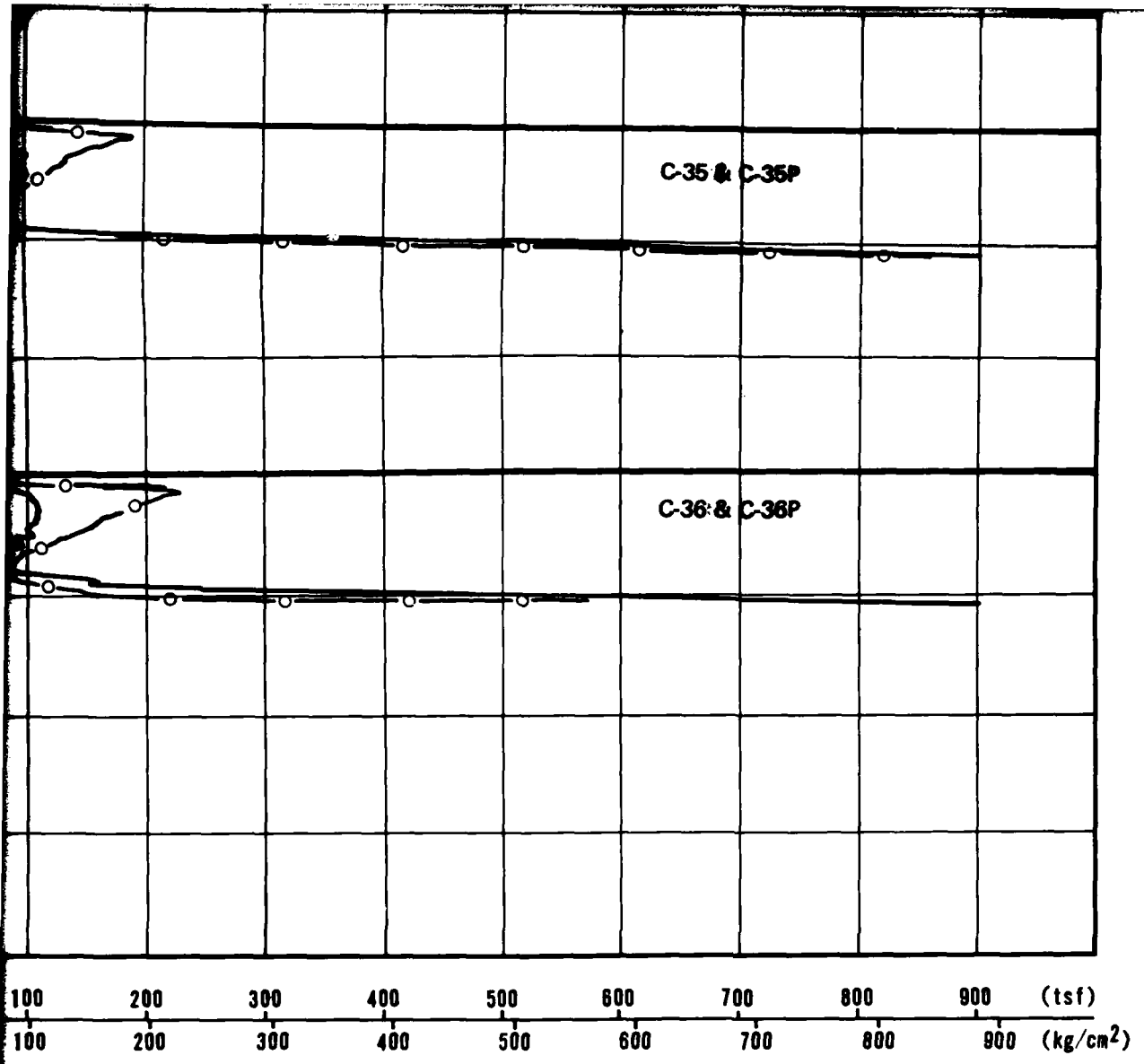

10
0
0
1
5
2
C-21
C-22
C-23
C-24
900 (tsf)
900 (kg/cm²)
0 100 200 300 400 500 600


C-21 & C-21P
C-22 & C-22P
C-23 & C-23P
C-24 & C-24P
600 700 800 900 (tsf)
600 700 800 900 (kg/cm²)
10
0 0
1 5
2
10
0 0
1 5
2
10
0 100 200 300 400
0 100 200 300 400
EXPLANATION
PRE-MOBILITY TEST CPTs
POST-MOBILITY TEST CPTs



EXPLANATION

— PRE-MOBILITY TEST CPTs

—o— POST-MOBILITY TEST CPTs

CONE PENETROMETER TEST RESULTS
TEST TRACKS C,G, AND VIRGIN DESERT
ETB MOBILITY STUDY
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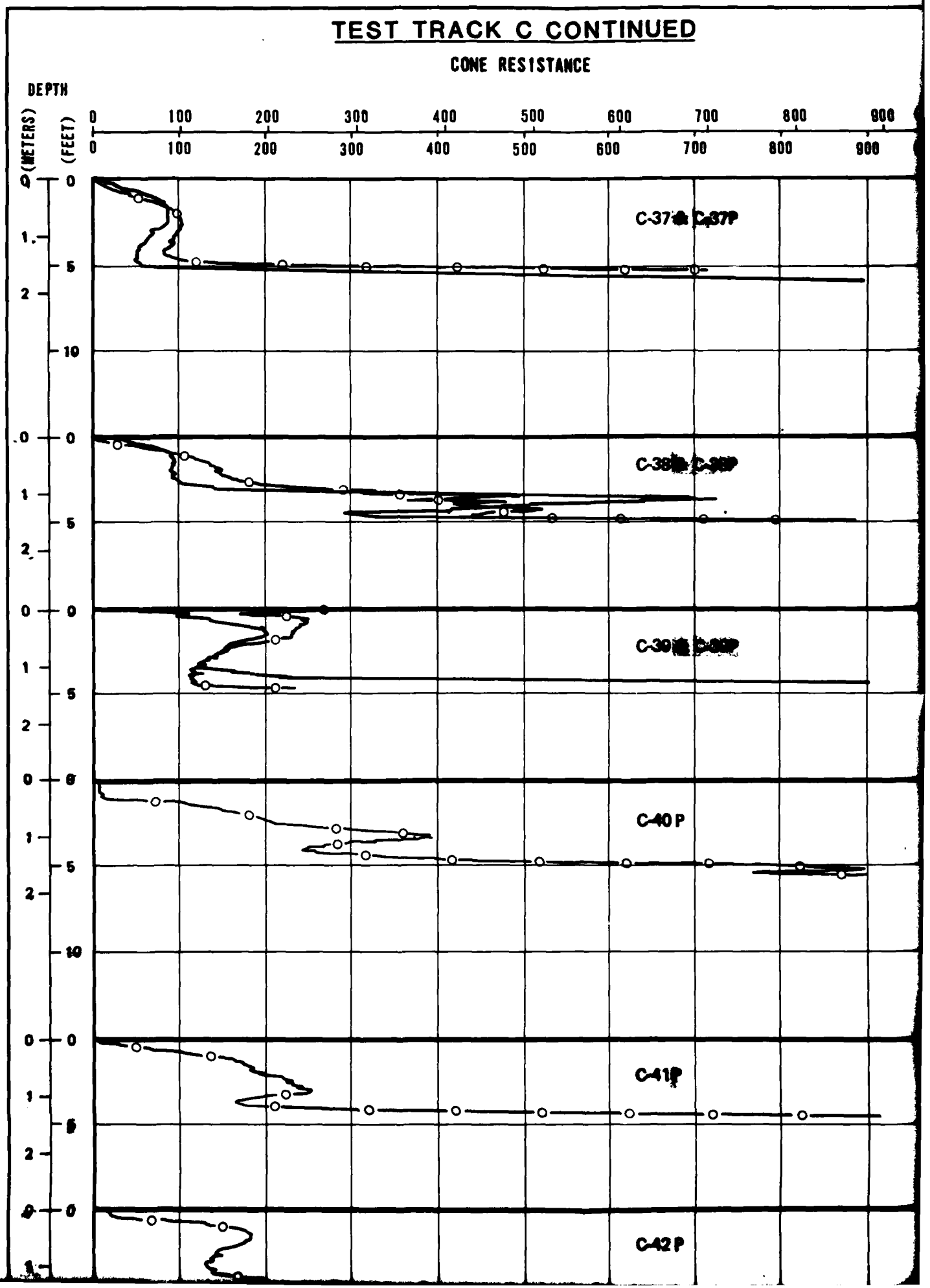
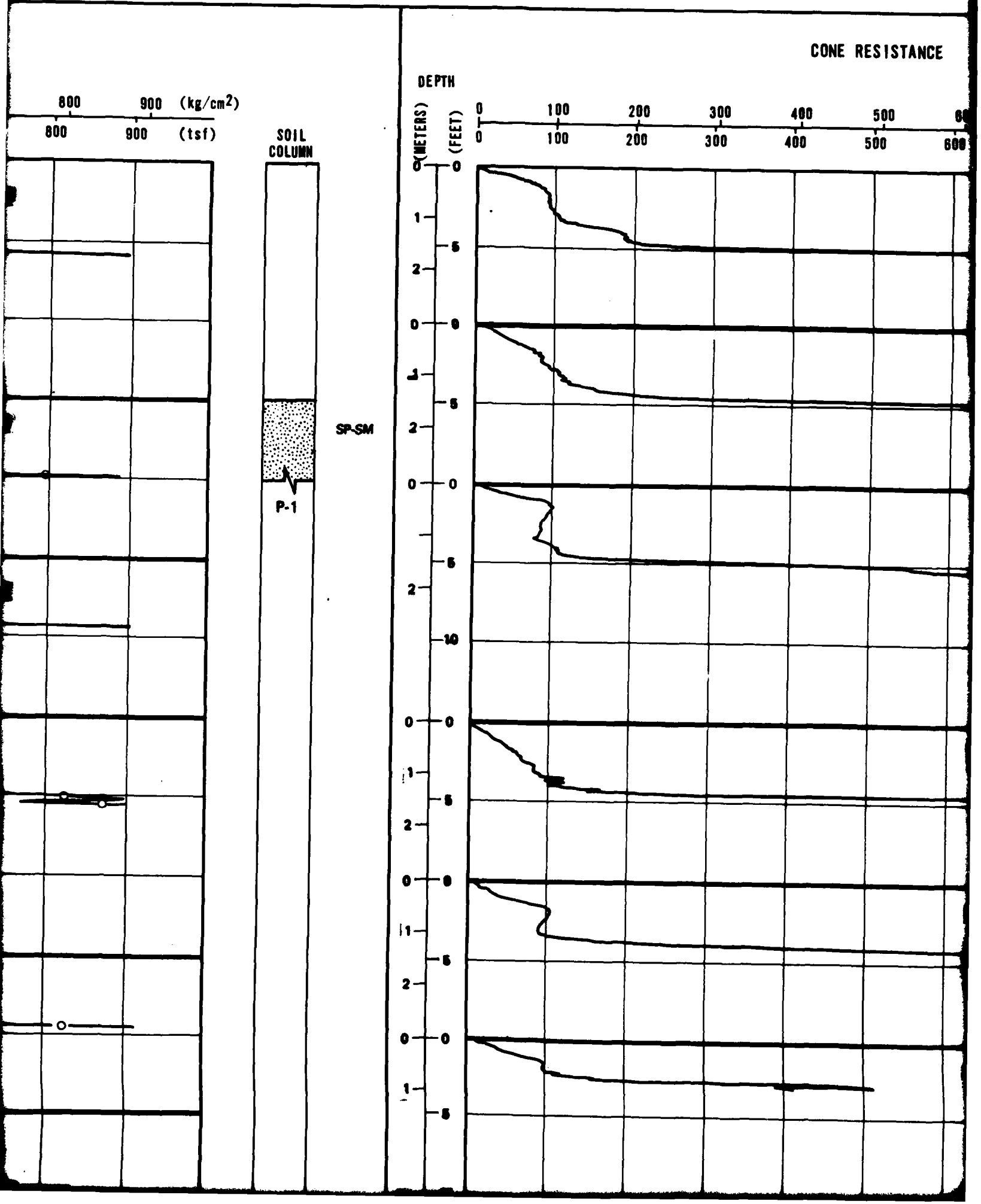
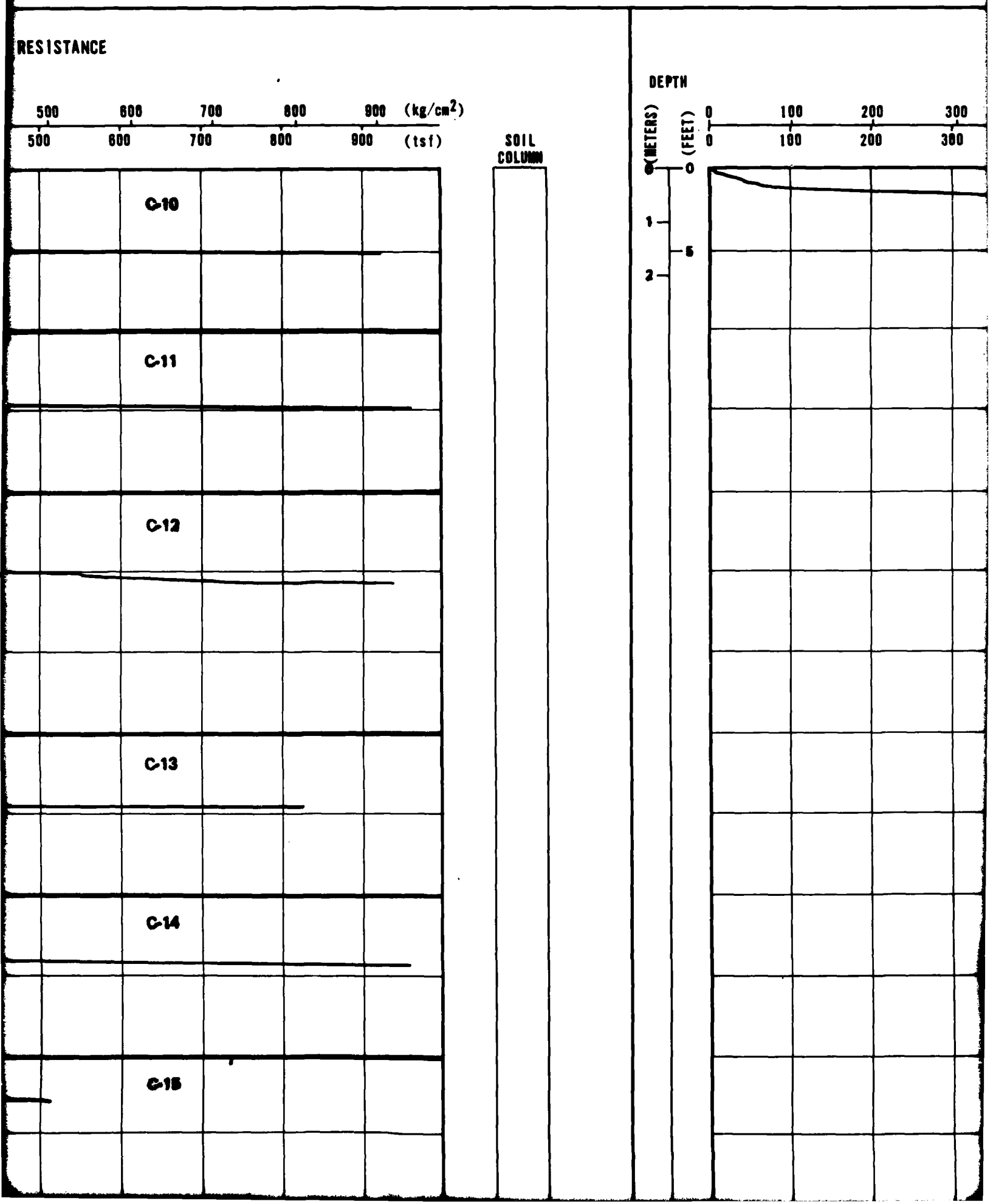
TEST TRACK C CONTINUED




CONE RESISTANCE
DEPTH
800
900
(kg/cm2)
800
900
(tsf)
SOIL COLUMN
SP-SM
P-1
(METERS)
(FEET)
0
100
200
300
400
500
600


RESISTANCE
500
600
700
800
900
(kg/cm²)
500
600
700
800
900
(tsf)
SOIL COLUMN
C-10
C-11
C-12
C-13
C-14
C-15
DEPTH
(METERS)
(FEET)
0
100
200
300
0
100
200
300
0
1
2
5

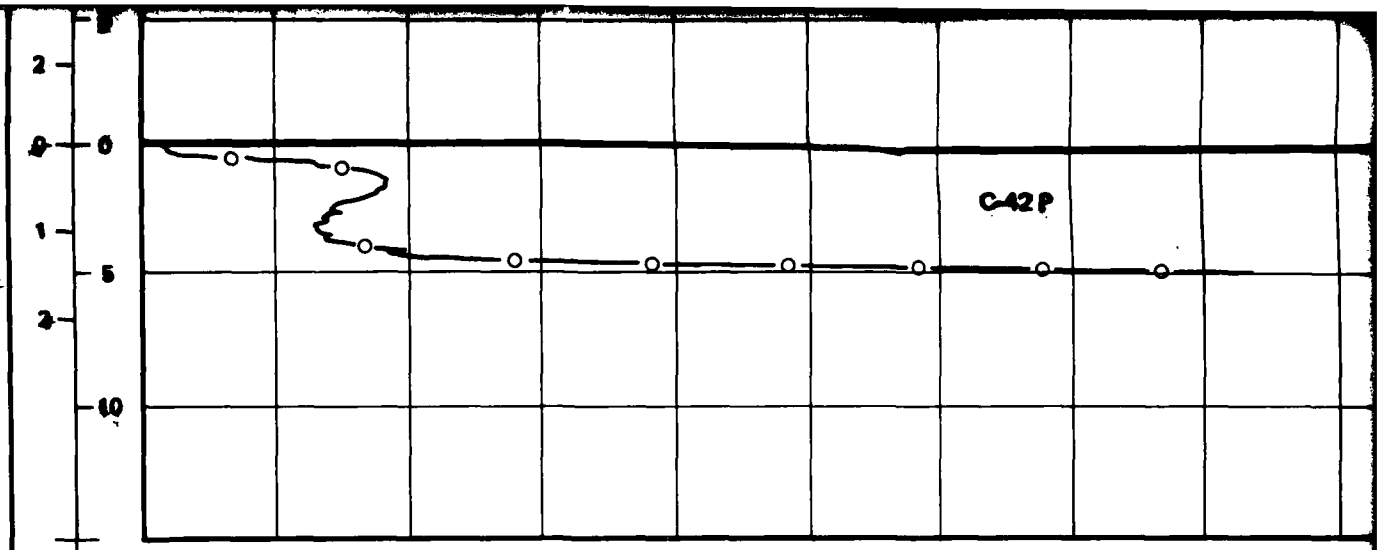
CONE RESISTANCE

100 200 300 400 500 600 700 800 900 (kg/cm^2)

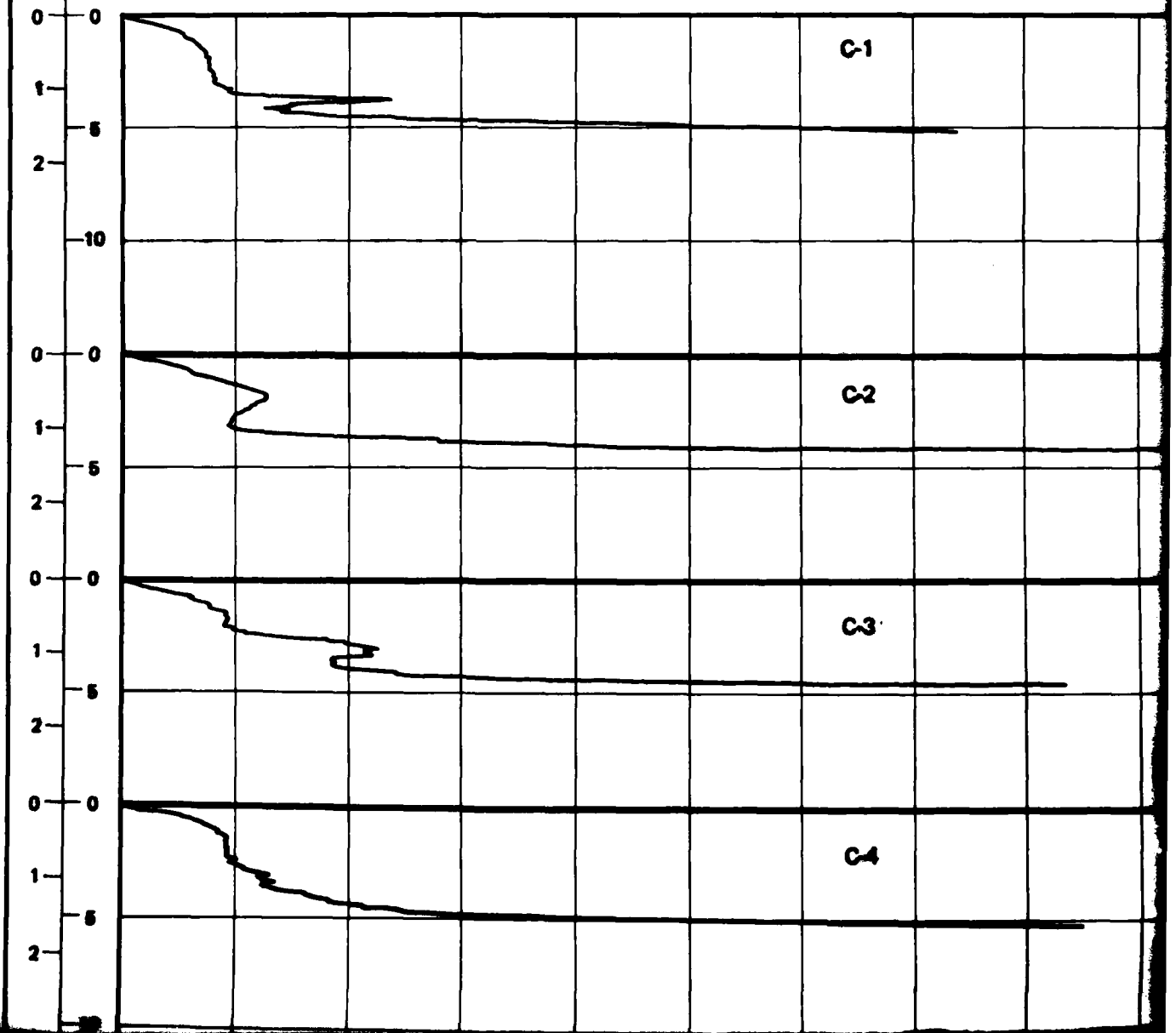
100 200 300 400 500 600 700 800 900 (tsf)

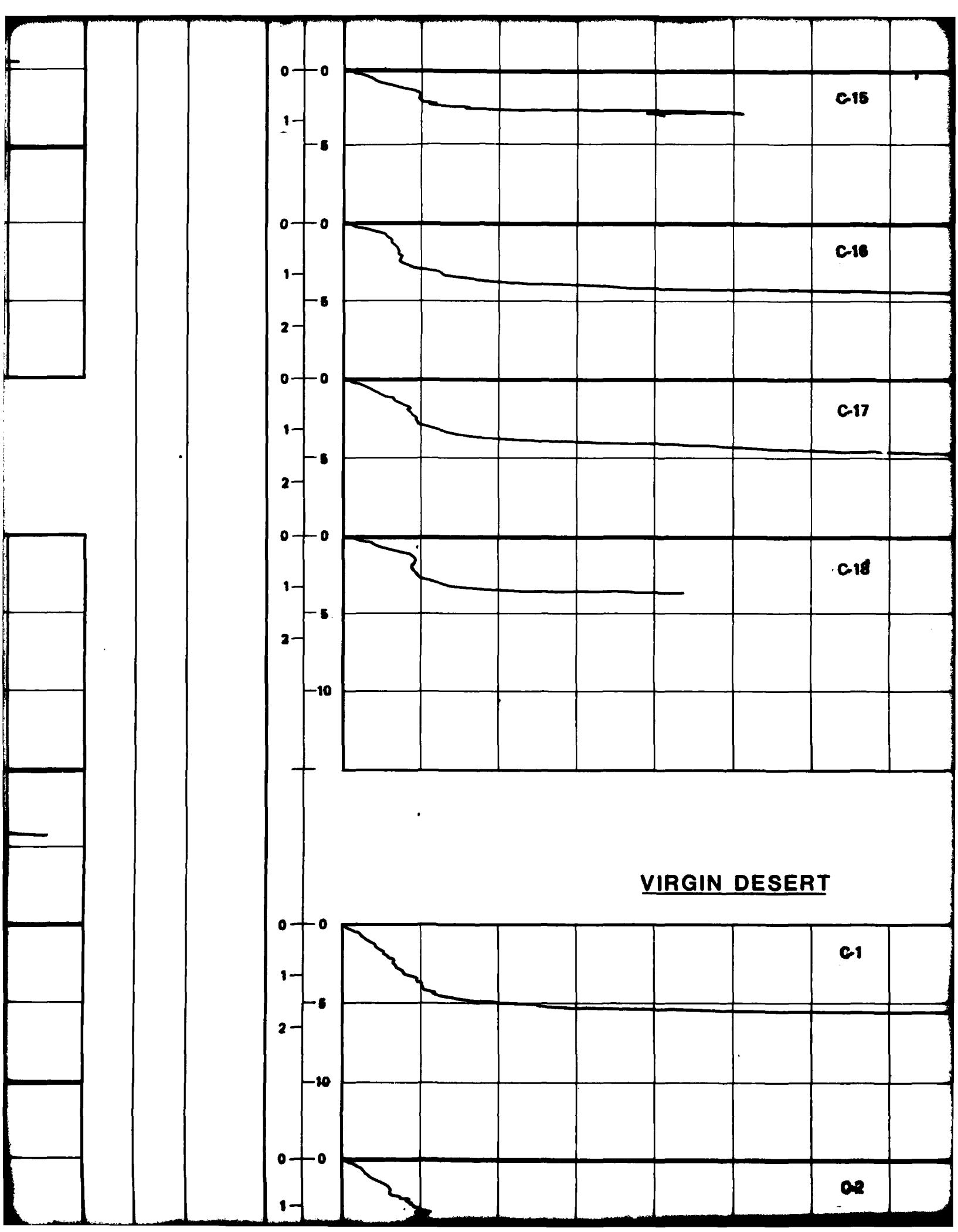
SOIL COLUMN

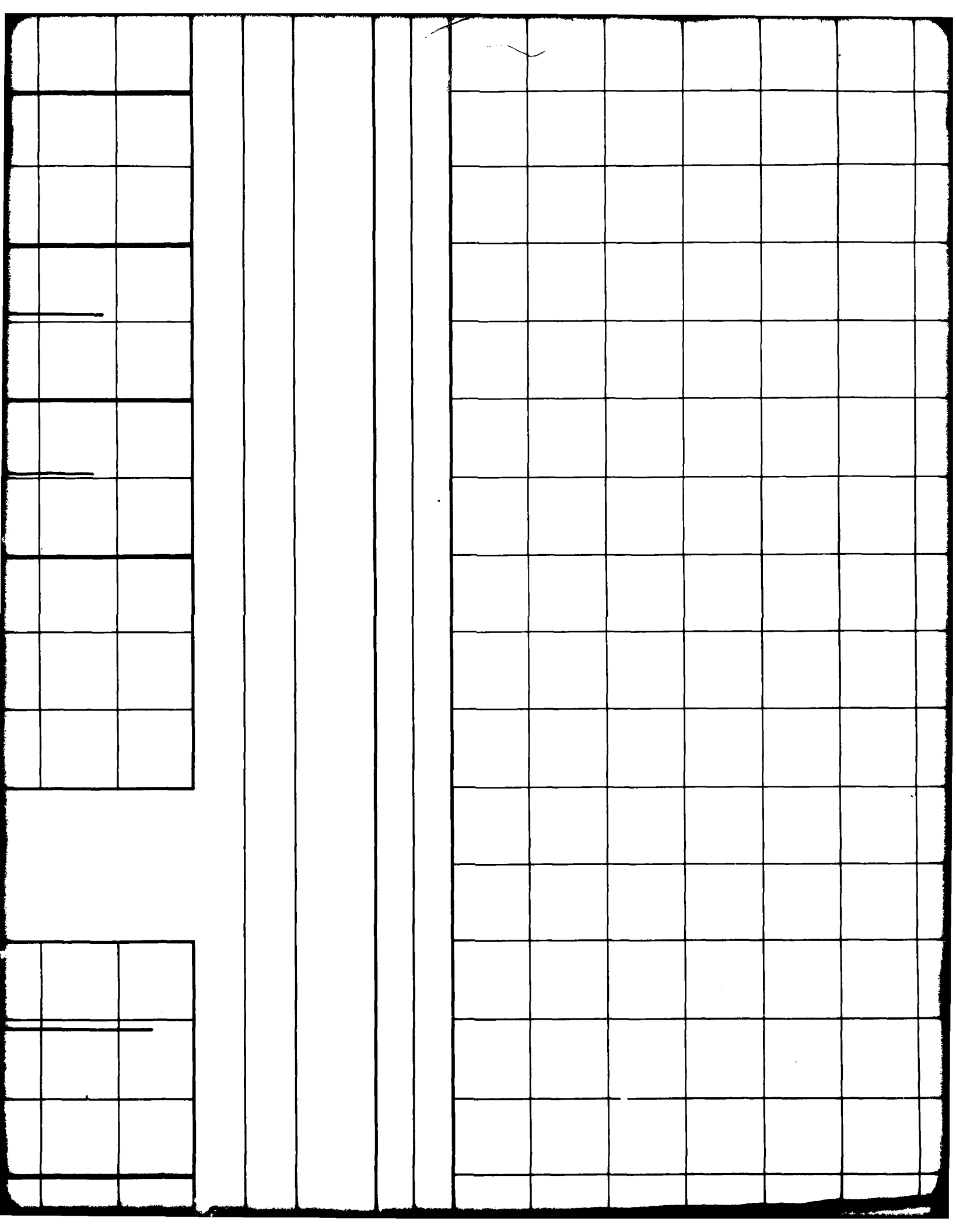
C-7

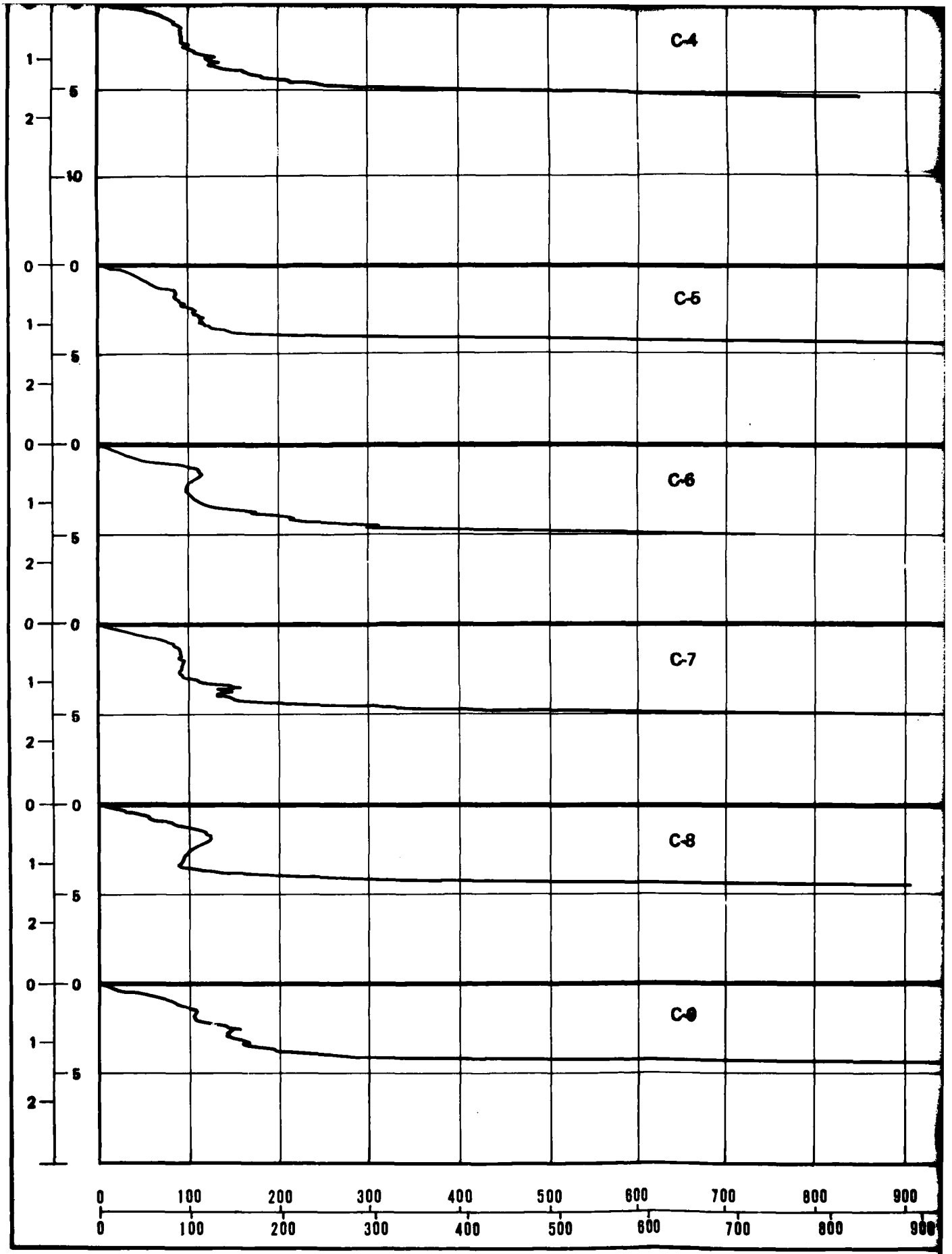


TEST TRACK G




0
0
1
5
C-15
0
0
1
5
2
C-16
0
0
1
5
2
C-17
0
0
1
5
2
10
C-18
VIRGIN DESERT
0
0
1
5
2
10
C-1
0
0
1
C-2





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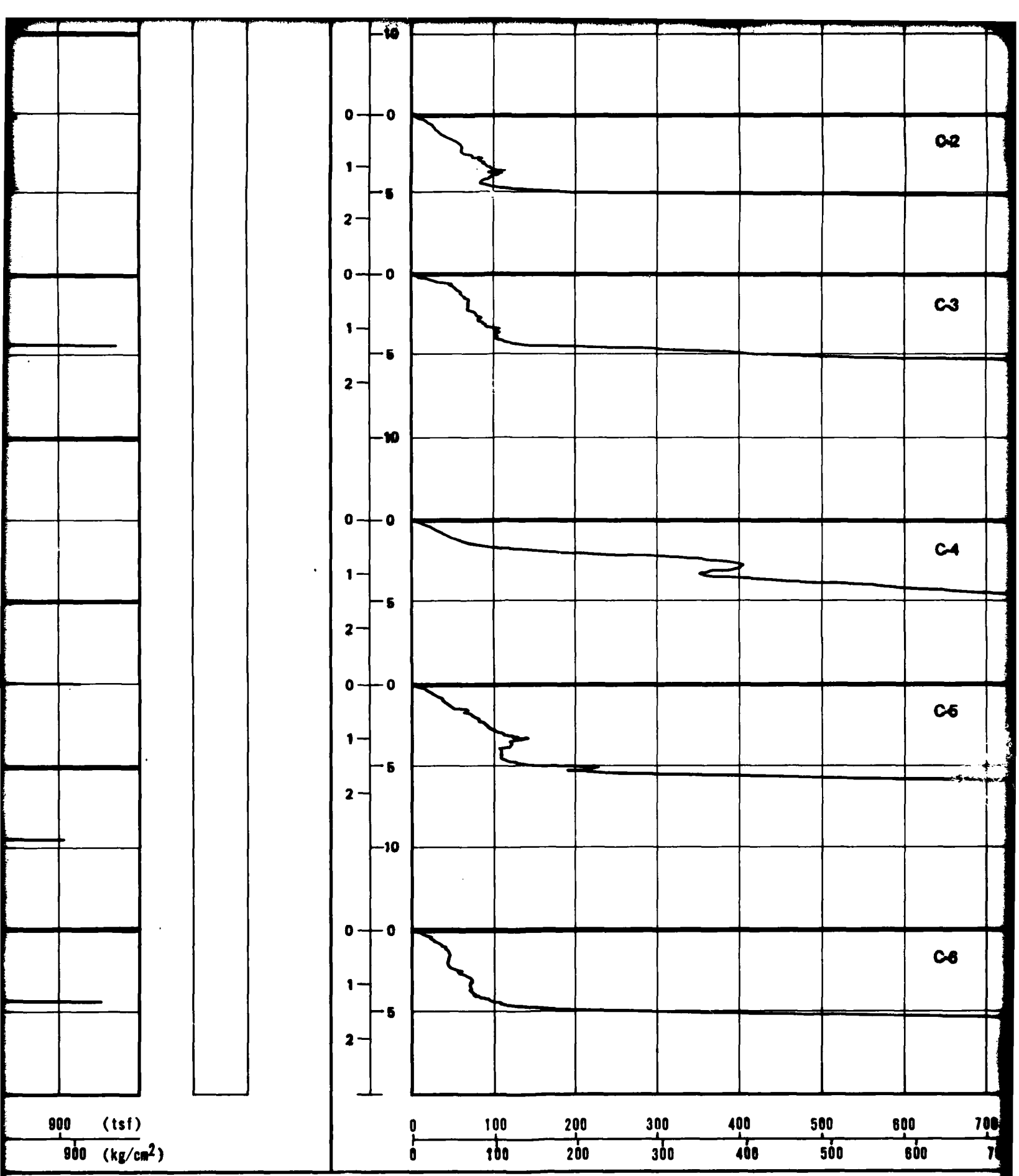
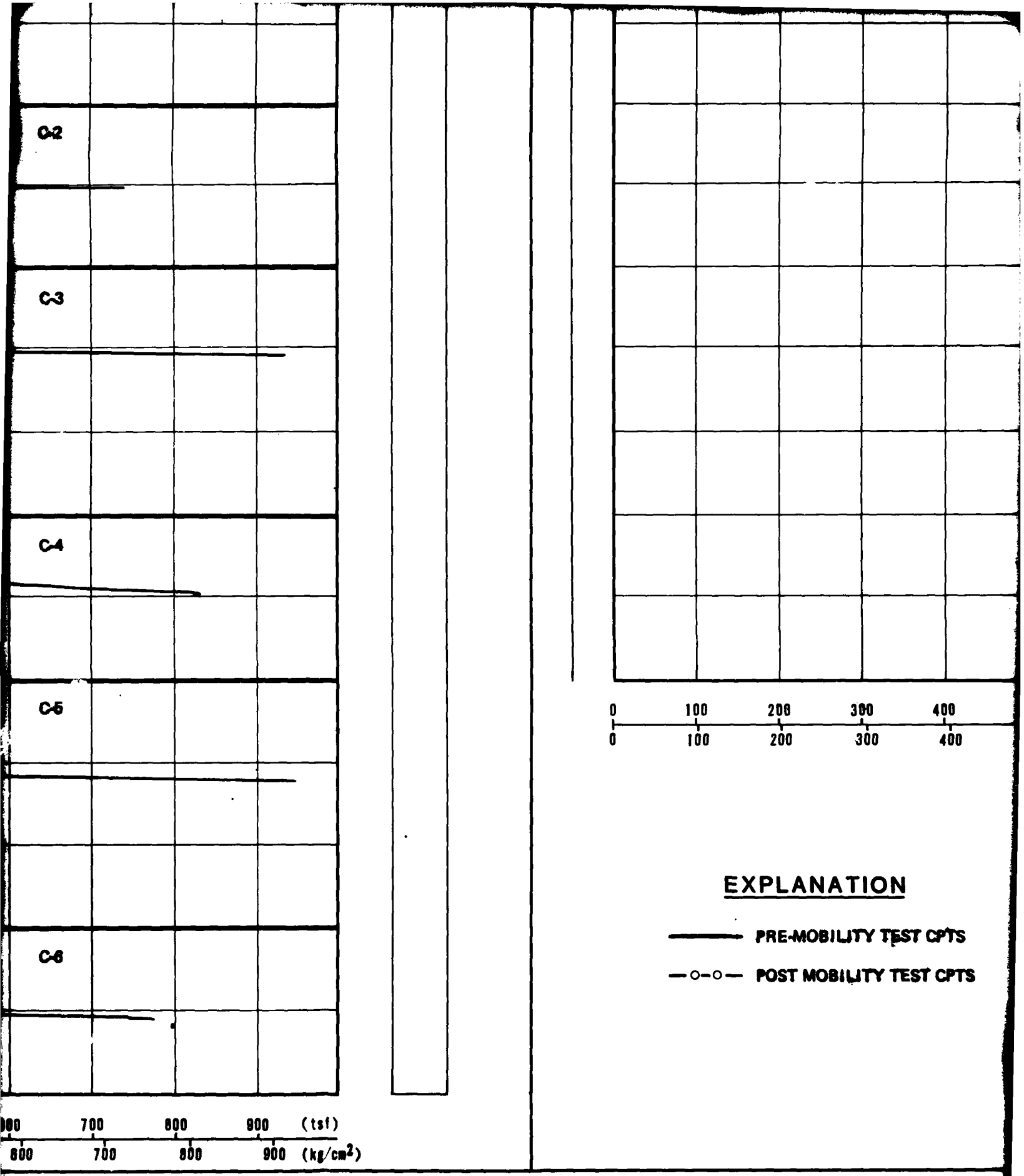
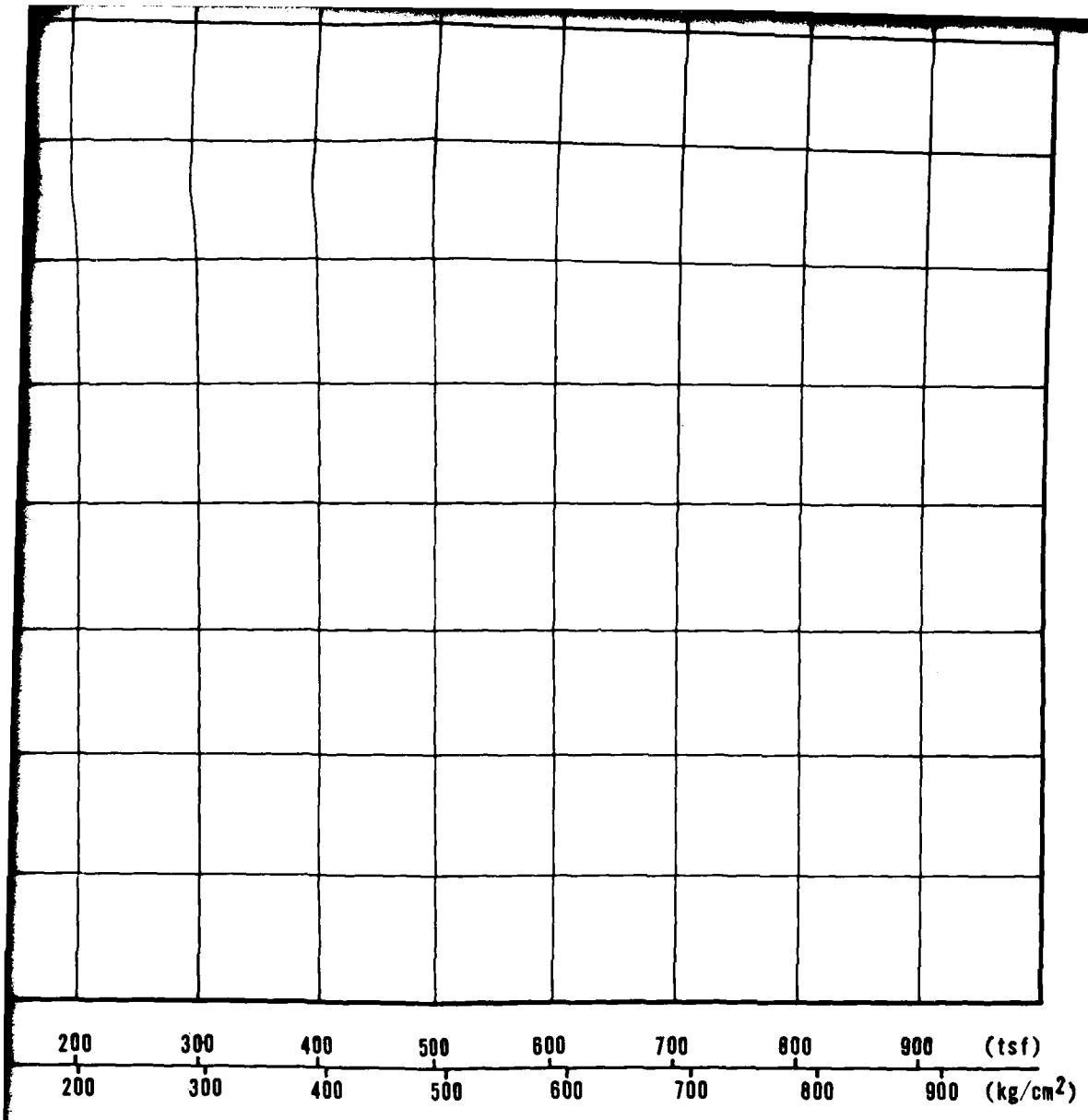

C-2
C-3
C-4
C-5
C-6
900 (tsf)
900 (kg/cm²)
0 100 200 300 400 500 600


C-2
C-3
C-4
C-5
C-6
0
100
200
300
400
0
100
200
300
400
700
800
900
(tsf)
700
800
900
(kg/cm²)
EXPLANATION
PRE-MOBILITY TEST CPTS
POST MOBILITY TEST CPTS



EXPLANATION

- PRE-MOBILITY TEST CPTS
- POST MOBILITY TEST CPTS

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TEST TRACKS C,G, AND VIRGIN DESERT
ETB MOBILITY STUDY
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APPENDIX C

Results of Laboratory Tests

C1.0 EXPLANATIONS OF LABORATORY TEST METHODS AND RESULTS

Laboratory test results are presented in this section. Table C-1 contains a summary of laboratory test results. This table contains results of sieve analysis; plasticity data; in-situ dry unit weight, moisture content, results of compaction tests; and specific gravity of solids. Other tests such as triaxial compression and California Bearing Ratio (CBR) are indicated on the table. Tables C-2 through C-5 present results of triaxial compression and CBR tests.

All tests were performed in general accordance with the American Society for Testing and Materials (ASTM) procedures. The following list presents the ASTM designations for the tests performed during the investigation.

Type of Test	ASTM Designations
Particle Size Analysis	D 422-63
Liquid Limit	D 423-66
Plastic Limit	D 424-59
Moisture Content	D 2216-71
Compaction	D 1557-70
Relative Density	D 2049-69
Specific Gravity of Solids	D 854-58
Triaxial Compression	D 2850-70
California Bearing Ratio (CBR)	D 1883-73

Explanation for the tables and figures presented in this section are as follows.

A. Test pit Number - Test pit designation.

B. Sample Number - Prefix indicates the type of sample; explanation is at the bottom of the table.

C. Sample Interval - This is the depth range measured from ground surface over which the sample was obtained.

D. Percent Finer by Weight - Presents the results of laboratory particle size analysis (ASTM D 422-63) performed on representative soil samples at the depth indicated. The numbers represent the percent (by dry weight) of the total sample weight passing through each sieve size indicated.

E. Atterberg Limits (ASTM D 423-66 and D 424-59)

LL - Liquid Limit, the water content (as percent of soil dry weight) corresponding to the arbitrary limit between the liquid and plastic states of consistency of a soil (ASTM D 423-66).

PL - Plastic Limit, the water content corresponding to an arbitrary limit between the plastic and the semisolid state of consistency of a soil (ASTM D 424-59).

PI - Plasticity Index, numerical difference between the liquid limit (LL) and the plastic limit (PL) indicating the range of moisture content within which a soil-water mixture is plastic.

NP - Nonplastic.

F. USCS - Unified Soil Classification Symbols are given here; see Table A-1 in Appendix A for complete details of USCS system.

G. In Situ - Presents results of field density and moisture contest tests.

Dry Unit Weight - indicates dry unit weight of soil determined as per sand cone method (ASTM D 1556-64)

Moisture Content - weight of water reported in percent of dry weight of soil sample

H. Compacted - Indicates results of laboratory maximum dry density and optimum moisture content test as per ASTM D 1557-70.

I. Specific Gravity of Solids (ASTM D 854-58) - Indicates the ratio of (1) the weight in air of a given volume of soil solids at a stated temperature, to (2) the weight in air of an equal volume of distilled water at a stated temperature.

J. Triaxial - The triaxial compression tests were performed in accordance with the procedures of ASTM D 2850-70. The following explanations and definitions apply.

Triaxial Compression Test - a cylindrical specimen of soil is surrounded by a fluid in a pressure chamber and subjected to an isotropic pressure. An additional compressive load is then applied, directed along the axis of the specimen called the axial load.

Consolidated-Drained (CD) Test - a triaxial compression test in which the soil was first consolidated under an all-around confining stress (test chamber pressure), and was then compressed (and hence sheared) by increasing the vertical stress. "Drained" indicates that excess pore water pressure generated by strains are permitted to dissipate by the free movement of pore water during consolidation and compression.

Consolidated-Undrained (CU) Test - a triaxial compression test in which essentially complete consolidation under the confining (chamber) pressure is followed by a shear test at constant water content.

Confining Pressure (G_3) - the isotropic chamber pressure applied to the soil specimen during consolidation and compression.

Maximum Deviator Stress ($G_1 - G_3$) - the difference between the major and minor principal stresses in the specimen at failure. The major principal stress on the specimen is equal to the unit axial load plus the chamber pressure and the minor principal stress on the specimen is equal to the chamber pressure.

Strain Rate - axial strain, E, at a given stress level is defined as the ratio of the change in length (L) of the specimen to the original length of the specimen (L_o). The rate of strain was controlled during the test so that this ratio increased at equal increments for each minute of testing.

Back Pressure - pressure in excess of atmospheric applied to the pore water of a soil sample. Back pressure is usually applied to (1) increase saturation of the sample, or (2) simulate the actual in-situ pressure regime.

K. CBR - California Bearing Ratio (CBR) is the ratio (in percent) of the resistance to penetration developed by a subgrade soil to that developed by a standard crushed-rock base material. The procedures for conducting a CBR test were as outlined in ASTM D 1883-73. The materials tested for CBR were also analyzed for particle size distribution (ASTM D 422-63) and compaction characteristics (ASTM D 1557-70), as well as relative density (ASTM D 2049-69). The term "percentage of maximum density" indicates the ratio (as a percentage) of the dry unit weight of the compacted sample to maximum dry density obtained in the laboratory

from ASTM D 1557-70, "Moisture-Density Relations of Soils Using 10-pound Hammer and 18-inch Drop."

L. Relative Density (R.D.)- indicates the state of denseness of a soil and is defined by:

$$R.D. = \frac{\gamma_d \text{ maximum } (\gamma_d - \gamma_d \text{ minimum}) \times 100\%}{d\ (\gamma_d \text{ maximum} - \gamma_d \text{ minimum})}$$

where γ_d maximum, γ_d minimum and γ_d are the dry densities of the soil as determined in the laboratory per ASTM method of test D-2049-69.

ACTIVITY NUMBER	SAMPLE NUMBER (a)	SAMPLE INTERVAL		PERCENT FINER BY WEIGHT									
				STANDARD SIEVE OPENING							U S STANDARD SI		
				BLDRS	COBBLES		GRAVEL				SAND		
		FEET	METERS	24"	12"	6"	3"	1½"	3/4"	3/8"	4	10	40
B-P-1	B-1	1.0-2.0	0.30-0.61					100	99	92	81	71	53
B-P-2	B-1	1.0-2.0	0.30-0.61					100	97	84	74	67	53
B-P-3	B-1	1.0-2.0	0.30-0.61					100	94	84	69	59	40
B-P-4	B-1	1.0-2.0	0.30-0.61					100	99	82	64	51	34
	b-2	2.0-3.0	0.61-0.91						100	96	78	61	29
	b-3	3.0-3.5	0.91-1.07						100	93	74	47	19
B-P-5	B-1	1.0-2.0	0.30-0.61					100	98	88	77	67	48
B-P-6	B-1	2.0-3.0	0.61.0.91					100	96	89	80	72	52
B-P-7	B-1	1.0-2.0	0.30-0.61					100	97	96	89	81	61
B-P-8	B-1	1.0-2.0	0.30-0.61					100	98	93	84	74	59
C-P-1	B-1	1.0-3.0	0.30-0.91						100	99	96	93	82
	b-3	3.0-3.5	0.91-1.07						100	95	87	77	56
	B-5	5.0-6.0	1.52-1.83				100	97	84	70	57	47	25
C-P-2	B-1	1.0-2.0	0.30-0.61						100	98	95	92	79
	b-3	3.0-3.5	0.91-1.07						100	94	86	77	59
C-P-3	B-1	1.0-2.0	0.30-0.61						100	98	95	90	74
	b-2	2.0-2.5	0.61-0.76						100	98	96	92	79
	B-3	3.0-5.0	0.91-1.52							100	98	95	83
C-P-4	b-1	1.0-1.5	0.30-0.46						100	98	94	88	76
	b-2	2.0-2.5	0.61-0.76						100	97	91	86	70
	b-3	3.0-3.5	0.91-1.07						100	91	80	68	49

NOTES:

(a) Sample types
B,b – Bulk

(b) NP – Not Plastic

(c) USCS – Unified Soil Classification System

(d) * Indicates that test has been performed and results are included in this report

NER BY WEIGHT								ATTERBERG LIMITS (b)			USCS (c)	IN-SITU					COMPACTED			SPECIFIC GRAVITY
U S STANDARD SIEVE NO					PARTICLE SIZE (mm)							DRY UNIT WEIGHT		MOISTURE CONTENT (%)	SATURATION (%)	VOID RATIO	MAXIMUM DRY DENSITY		OPTIMUM MOISTURE (%)	
SAND				SILT OR CLAY																
3"	4	10	40	100	200	.005	.001	LL	PL	PI		(pcf)	(kg/m³)				(pcf)	(kg/m³)		
2	81	71	53	20	12					NP	SW-SM	115.9	1857	8.0						2.66
4	74	67	53	15	7					NP	SP-SM									
8	69	59	40	17	9					NP	SP-SM	113.5	1818	7.0						2.61
2	64	51	34	14	7					NP	SP-SM	105.2	1685	4.8			122.8	1967	10.0	2.64
6	78	61	29	10	5					NP	SP-SM	104.8	1679	3.0						
3	74	47	19	8	5					NP	SW-SM	112.1	1796	2.0						
8	77	67	48	20	12					NP	SP-SW	114.5	1834	7.0						
9	80	72	52	16	9					NP	SP-SM	93.7	1501	3.2			117.2	1878	12.0	2.63
6	89	81	61	21	10					NP	SP-SM	109.6	1757	5.4			123.1	1972	10.8	
3	84	74	59	17	9					NP	SP-SM	99.9	1600	4.7						2.66
9	96	93	82	23	7					NP	SP-SM	110.2	1765	4.9			107.3	1719	12.0	2.65
5	87	77	56	13	7						SP-SM	108.5	1738	7.6						
0	57	47	25	8	5						SP-SM									
8	95	92	79	24	10						SP-SM	105.0	1682	5.0						2.65
4	86	77	59	19	9						SP-SM	107.8	1727	6.8						
8	95	90	74	19	8						SP-SM	108.5	1738	5.6			111.0	1778	12.5	
8	96	92	79	23	9						SP-SM	100.0	1602	6.1						
00	98	95	83	27	10						SP-SM	107.4	1721	5.9						
8	94	88	76	25	11						SP-SM	97.9	1568	5.8						
7	91	86	70	23	10						SP-SM	104.8	1679	6.3						
1	80	68	49	12	6						SW-SM	112.0	1794	6.0						2.65

LL	PL	PI		(pcf)	(kg/m^3)				(pcf)	(kg/m^3)			
		NP	SW-SM	115.9	1857	8.0						2.66	
		NP	SP-SM										
		NP	SP-SM	113.5	1818	7.0						2.61	
		NP	SP-SM	105.2	1685	4.8			122.8	1967	10.0	2.64	*
		NP	SP-SM	104.8	1679	3.0							
		NP	SW-SM	112.1	1796	2.0							
		NP	SP-SW	114.5	1834	7.0							
		NP	SP-SM	93.7	1501	3.2			117.2	1878	12.0	2.63	
		NP	SP-SM	109.6	1757	5.4			123.1	1972	10.8		*
		NP	SP-SM	99.9	1600	4.7						2.66	
		NP	SP-SM	110.2	1765	4.9			107.3	1719	12.0	2.61	
			SP-SM	108.5	1738	7.6							
			SP-SM										
			SP-SM	105.0	1682	5.0						2.61	
			SP-SM	107.8	1727	6.8							
			SP-SM	108.5	1738	5.6			111.0	1778	12.5		*
			SP-SM	100.0	1602	6.1							
			SP-SM	107.4	1721	5.9							
			SP-SM	97.9	1568	5.8							
			SP-SM	104.8	1679	6.3							
			SW-SM	112.0	1794	6.0						2.62	

TEST PLT NO.	SAMPLE NO.	SAMPLE INTERVAL		SOIL TYPE	TYPE OF TEST	DRY DENSITY		MOISTURE CONTENT (%)	CONFINING PRESSURE (σ_3)		MAXIMUM DEVIATOR STRESS ($\sigma_1-\sigma_3$)		STRAIN RATE (% min)	BACK PRESSURE	
		FEET	METERS			pcf	kg/m^3		ksf	kN/m^2	ksf	kN/m^2		ksf	kN/m^2
B-P-4	B-1	1.0 -2.0	0.30 - 0.61	SP-SM	CD	117.7	1886	10.3	0.6	29	7.1	340	0.08	0	0
				SP-SM	CD	118.7	1902	10.0	1.2	57	10.4	498	0.08	0	0
				SP-SM	CD	118.7	1902	10.1	2.3	110	18.0	862	0.10	0	0
				SP-SM	CD	118.5	1898	9.7	4.6	220	30.7	1470	0.10	0	0
				SP-SM	CD	110.7	1773	10.0	0.6	29	3.4	163	0.08	0	0
				SP-SM	CD	110.6	1772	10.1	1.2	57	6.0	287	0.10	0	0
				SP-SM	CD	110.8	1775	10.3	2.3	110	10.4	498	0.08	0	0
				SP-SM	CD	111.0	1778	9.8	4.6	220	16.6	795	0.08	0	0
				SP-SM	CD	98.0	1570	11.7	0.6	29	2.4	115	0.10	0	0
				SP-SM	CD	98.2	1573	10.2	1.2	57	3.7	177	0.08	0	0
				SP-SM	CD	97.9	1568	10.5	2.3	110	6.8	326	0.09	0	0
				SP-SM	CD	97.4	1560	11.0	4.6	220	14.0	670	0.10	0	0
				SP-SM	CD	119.6	1916	2.8	0.6	29	9.4	450	0.08	0	0
				SP-SM	CD	119.3	1911	2.9	1.2	57	12.8	613	0.08	0	0
				SP-SM	CD	119.6	1916	2.9	2.3	110	17.1	819	0.08	0	0
				SP-SM	CD	119.1	1908	3.1	4.6	220	31.7	1518	0.08	0	0
				SP-SM	CD	112.6	1804	2.8	0.6	29	4.5	2.15	0.09	0	0
				SP-SM	CD	112.5	1802	3.1	1.2	57	7.5	359	0.09	0	0
				SP-SM	CD	112.6	1804	2.9	2.3	110	12.9	618	0.09	0	0
				SP-SM	CD	112.5	1802	3.1	4.6	220	22.6	1082	0.09	0	0

SUMMARY OF TRIAXIAL COMPRESSION
TEST RESULTS, TEST TRACK R ETB MOBILITY
STUDY, NEVADA TEST S... NEVADA

MX SITING INVESTIGATION
DEPARTMENT OF THE AIR FORCE BMO

TABLE C-2 1 of 2

WOODWARD-NATIONAL, INC.

AFV-10

TEST PIT NO.	SAMPLE NO.	SAMPLE INTERVAL		SOIL TYPE	TYPE OF TEST	DRY DENSITY		MOISTURE CONTENT (%)	CONFINING PRESSURE (σ_3)		MAXIMUM DEVIATOR STRESS ($\sigma_1-\sigma_3$)		STRAIN RATE (% min)	BACK PRESSURE	
		FEET	METERS			pcf	kg/m^3		ksf	kN/m^2	ksf	kN/m^2		ksf	kN/m^2
B-P-4	B-1	1.0 - 2.0	0.30 - 0.61	SP-SM	CD	100.4	1608	2.8	0.6	29	17.8	852	0.09	0	0
				SP-SM	CD	100.0	1602	3.0	1.2	57	9.7	464	0.09	0	0
				SP-SM	CD	99.1	1588	4.1	2.3	110	5.0	239	0.09	0	0
				SP-SM	CD	99.5	1594	3.6	4.6	220	2.7	129	0.09	0	0
B-P-7	B-1	1.0 - 2.0	0.30 - 0.61	SP-SM	CD	119.8	1919	11.7	0.6	29	5.3	254	0.09	0	0
				SP-SM	CD	119.9	1921	11.6	1.2	57	8.0	383	0.08	0	0
				SP-SM	CD	120.5	1930	11.5	2.3	110	14.2	680	0.10	0	0
				SP-SM	CD	120.3	1927	11.6	4.6	220	24.2	1159	0.08	0	0
				SP-SM	CD	107.4	1721	14.3	0.6	29	2.4	115	0.09	0	0
				SP-SM	CD	107.0	1714	14.8	1.2	57	4.0	192	0.10	0	0
				SP-SM	CD	107.3	1719	14.4	2.3	110	7.4	354	0.10	0	0
				SP-SM	CD	109.7	1757	12.0	4.6	220	13.7	656	0.10	0	0
				SP-SM	CD	96.8	1551	12.8	0.6	29	1.6	77	0.09	0	0
				SP-SM	CD	96.0	1538	14.5	1.2	57	3.0	144	0.10	0	0
				SP-SM	CD	95.2	1525	15.2	2.3	110	5.4	259	0.10	0	0
				SP-SM	CD	95.9	1536	14.4	4.6	220	11.7	560	0.09	0	0
				SP-SM	CD	115.8	1855	4.4	0.6	29	9.5	455	0.08	0	0
				SP-SM	CD	116.4	1865	4.1	1.2	57	14.1	675	0.08	0	0
				SP-SM	CD	115.9	1857	6.0	2.3	110	24.5	1173	0.08	0	0
				SP-SM	CD	115.2	1846	4.1	4.6	220	36.7	1757	0.08	0	0

SUMMARY OF TRIAXIAL COMPRESSION
TEST RESULT, TEST TRSCK B, ETB MOBILITY
STUDY, NEVADA TEST SITE, NEVADA

MX SITING INVESTIGATION
DEPARTMENT OF THE AIR FORCE BMO

TABLE C-2
2 of 2

WOODWARD-CLYDE CONSULTANTS

AFV-10

CHECKED BY _____ APPROVED BY _____

SAMPLE NUMBER	SOIL TYPE	PERCENT PASSING #200	ATTERBERG LIMITS LL	ATTERBERG LIMITS PI	SPECIFIC GRAVITY	MAXIMUM DRY DENSITY pcf	MAXIMUM DRY DENSITY kg/m³	OPTIMUM MOISTURE (%)	COMPACTED DRY DENSITY pcf	COMPACTED DRY DENSITY kg/m³	COMPACTED MOISTURE (%)	PERCENT OF MAXIMUM DRY DENSITY	CBR (%)
B-P-4 (B-1)	SP-SM	7		NP	2.64	122.8	1967	10.0	114.0	1826	10.2	92.8	43*
									101.0	1618	9.8	82.3	1 *
									113.0	1810	5.0	92.0	70
									107.0	1714	5.2	87.1	5
									111.3	1783	2.4	90.6	8
									101.0	1618	2.2	82.3	3
B-P-6 (B-1)	SP-SM	9		NP	2.63	117.2	1878	12.0	115.1	1844	4.8	98.2	81
									110.0	1762	5.0	93.9	56
									102.6	1644	4.9	87.5	12

* SOAKED TESTS - ALL OTHERS UNSOAKED

CALIFORNIA BEARING RATIO (CBR)
TEST RESULTS, TEST TRACK B
ETB MOBILITY STUDY
NEVADA TEST SITE, NEVADA

MX SITING INVESTIGATION
DEPARTMENT OF THE AIR FORCE - [redacted]

TABLE C-3 1 of 2

WILLBROS NATIONAL, INC.

USAF -00

CHECKED BY PRO

SAMPLE NUMBER	SOIL TYPE	PERCENT PASSING #200	ATTERBERG LIMITS		SPECIFIC GRAVITY	MAXIMUM DRY DENSITY		OPTIMUM MOISTURE (%)	COMPACTED DRY DENSITY		COMPACTED MOISTURE (%)	PERCENT OF MAXIMUM DRY DENSITY	CBR (%)
			LL	PI		pcf	kg/m³		pcf	kg/m³			
B-P-7 (B-1)	SP-SM	10		NP		123.1	1972	10.8	116.0	1858	11.1	94.3	45 *
									114.0	1826	11.2	92.6	39 *
									109.7	1757	10.7	89.1	16 *
									98.5	1578	10.5	80.0	1 *
									115.9	1857	6.1	94.2	94
									106.1	1700	6.0	86.2	26
B-P-8 (B-1)	SP-SM	9		NP	2.66				115.2	1846	2.9	93.6 **	63
									111.6	1788	2.9	90.7 **	19
									100.1	1604	2.8	81.4 **	1

* SOAKED TEST - ALL OTHERS UNSOAKED

** ESTIMATED BY USING MAXIMUM DRY DENSITY OF 123.0 pcf (AVERAGE OF 122.8 AND 123.1 pcf)

CALIFORNIA BEARING RATIO (CBR) TEST RESULTS, TEST TRACK B ETB MOBILITY STUDY NEVADA TEST SITE, NEVADA

MX SITING INVESTIGATION DEPARTMENT OF THE AIR FORCE - BMO

TABLE C-3 2 of 2

WOODWARD-NATIONAL, INC.

USAF -80

CHECKED BY _____ APPROVED BY _____

TEST PIT NO.	SAMPLE NO.	SAMPLE INTERVAL		SOIL TYPE	TYPE OF TEST	DRY DENSITY		MOISTURE CONTENT (%)	CONFINING PRESSURE (σ_3)		MAXIMUM DEVIATOR STRESS ($\sigma_1 - \sigma_3$)		STRAIN RATE (% min)	BACK PRESSURE	
		FEET	METERS			pcf	kg/m³		ksf	kN/m²	ksf	kN/m²		ksf	kN/m²
C-P-7	B-1	1.0 - 2.0	0.30 - 0.61	SP-SM	CD	109.7	1757	4.7	0.6	29	5.9	282	0.08	0	0
				SP-SM	CD	110.3	1767	4.0	1.2	57	9.7	464	0.08	0	0
				SP-SM	CD	109.8	1759	4.6	2.3	110	14.2	680	0.09	0	0
				SP-SM	CD	109.8	1759	4.3	4.6	220	19.9	953	0.10	0	0
				SP-SM	CD	97.8	1567	4.8	0.6	29	2.3	110	0.08	0	0
				SP-SM	CD	98.0	1570	4.6	1.2	57	4.2	201	0.09	0	0
				SP-SM	CD	98.2	1573	4.2	2.3	110	8.1	388	0.08	0	0
				SP-SM	CD	98.1	1572	4.2	4.6	220	14.8	709	0.08	0	0
C-P-3	B-1	1.0 - 2.0	0.30 - 0.61	SP-SM	CD	109.7	1757	12.5	0.6	29	3.3	158	0.10	0	0
				SP-SM	CD	109.4	1753	12.7	1.2	57	5.5	263	0.08	0	0
				SP-SM	CD	109.6	1756	12.5	2.3	110	10.0	479	0.10	0	0
				SP-SM	CD	109.9	1761	12.3	4.6	220	18.4	881	0.09	0	0
				SP-SM	CD	104.3	1671	11.9	0.6	29	2.4	115	0.10	0	0
				SP-SM	CD	103.8	1663	12.4	1.2	57	4.8	230	0.10	0	0
				SP-SM	CD	103.5	1658	12.8	2.3	110	7.9	378	0.09	0	0
				SP-SM	CD	103.9	1664	12.4	4.6	220	15.3	733	0.08	0	0
				SP-SM	CD	98.5	1578	11.6	0.6	29	1.7	81	0.08	0	0
				SP-SM	CD	98.4	1576	11.8	1.2	57	3.2	153	0.10	0	0
				SP-SM	CD	98.4	1576	11.7	2.3	110	6.0	287	0.10	0	0
				SP-SM	CD	98.2	1573	12.0	4.6	220	11.5	551	0.10	0	0

SUMMARY OF TRIAXIAL COMPRESSION TEST RESULTS, TEST TRACK C, ETB MOBILITY STUDY, NEVADA TEST SITE, NEVADA

MX SITING INVESTIGATION
DEPARTMENT OF THE AIR FORCE BMO

TABLE C-4
1 OF 2

FUGRO NATIONAL, INC.

AFV-10

TEST PIT NO.	SAMPLE NO.	SAMPLE INTERVAL		SOIL TYPE	TYPE OF TEST	DRY DENSITY		MOISTURE CONTENT (%)	CONFINING PRESSURE (σ_3)		MAXIMUM DEVIATOR STRESS ($\sigma_1 - \sigma_3$)		STRAIN RATE	BACK PRESSURE	
		FEET	METERS			pcf	kg/m^3		ksf	kN/m^2	ksf	kN/m^2	(%/min)	ksf	kN/m^2
C-P-3	B-1	1.0 - 2.0	0.30 - 0.61	SP-SM	CD	109.7	1746$_6$	4.8	0.6	29	4.7	225	0.08	0	0
				SP-SM	CD	107.3	1719	5.2	1.2	57	6.9	330	0.08	0	0
				SP-SM	CD	107.5	1722	5.2	2.3	110	11.8	565	0.08	0	0
				SP-SM	CD	108.8	1743	5.1	4.6	220	21.9	1049	0.08	0	0
				SP-SM	CD	104.6	1676	4.9	0.6	29	2.5	120	0.08	0	0
				SP-SM	CD	104.6	1676	4.9	1.2	57	5.2	249	0.08	0	0
				SP-SM	CD	104.3	1671	5.0	2.3	110	8.8	421	0.08	0	0
				SP-SM	CD	104.4	1672	5.1	4.6	220	17.7	874	0.08	0	0
				SP-SM	CD	98.5	1578	5.0	0.6	29	2.2	105	0.08	0	0
				SP-SM	CD	98.4	1576	5.2	1.2	57	3.5	168	0.08	0	0
				SP-SM	CD	98.5	1578	4.9	2.3	110	6.5	311	0.08	0	0
				SP-SM	CD	98.5	1578	5.0	4.6	220	12.6	603	0.08	0	0

SUMMARY OF TRIAXIAL COMPRESSION TEST RESULTS, TEST TRACK C, ETB MOBILITY STUDY, NEVADA TEST SITE, NEVADA

MX SITING INVESTIGATION
DEPARTMENT OF THE AIR FORCE BMO

TABLE C-4 2 OF 2

FUGRO NATIONAL, INC.

SAMPLE NUMBER	SOIL TYPE	PERCENT PASSING #200	ATTERBERG LIMITS		SPECIFIC GRAVITY	MAXIMUM DRY DENSITY		OPTIMUM MOISTURE	COMPACTED DRY DENSITY		COMPACTED MOISTURE	PERCENT OF MAXIMUM DRY DENSITY	CBR
			LL	PI		pcf	kg/m³	(%)	pcf	kg/m³	(%)		(%)
C-P-1 (B-1)	SP-SM	7		NP	2.61	107.3	1719	12.0	102.5	1642	11.8	95.5	32 •
									99.9	1600	11.6	93.1	25 •
									99.0	1586	12.2	92.3	21 •
									109.7	1757	6.8	102.0	50
									105.0	1682	6.8	98.0	36
									95.0	1522	6.9	86.0	2
									109.7	1757	5.2	102.3	53
									106.9	1713	5.3	99.6	29
									85.5	1370	5.2	79.7	2
C-P-3 (B-1)	SP-SM	8				111.0	1778	12.5	109.6	1756	12.3	98.7	45 •
									105.7	1693	12.5	95.2	20 •
									91.7	1469	12.5	82.6	1 •
									111.3	1783	6.6	100.0	57
									107.2	1717	6.8	97.0	49
									95.0	1522	6.7	86.0	11
									111.9	1793	4.8	100.8	78
									109.7	1757	5.4	98.8	56
									108.7	1709	5.6	96.2	49
									104.0	1666	5.0	93.7	21
									98.1	1572	5.1	88.4	8
									88.3	1415	5.8	79.5	1

• SOAKED TESTS - ALL OTHERS UNSOAKED

TABLE C-5

MX SITING INVESTIGATION
DEPARTMENT OF THE AIR FORCE - BMO

CALIFORNIA BEARING RATIO (CBR)
TEST RESULTS, TEST TRACK C
ETB MOBILITY STUDY
NEVADA TEST SITE, NEVADA

WOODWARD-CLYDE CONSULTANTS

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